A330 RR Trent 700
TECHNICAL TRAINING MANUAL
CMQ Inter Family : SA -> A330 RR Trent 700 - T1
POWER PLANT (RR Trent 700)

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GCL13151 - G6RT1DU

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

POWERPLANT INTRODUCTION

The Rolls-Royce RB211-Trent 772 series engine is an axial flow, triple spool, high bypass-ratio, turbo-fan engine. The RR RB-211Trent 772 powers the A330 aircraft and produces approximately 71.000 lbf. of thrust.

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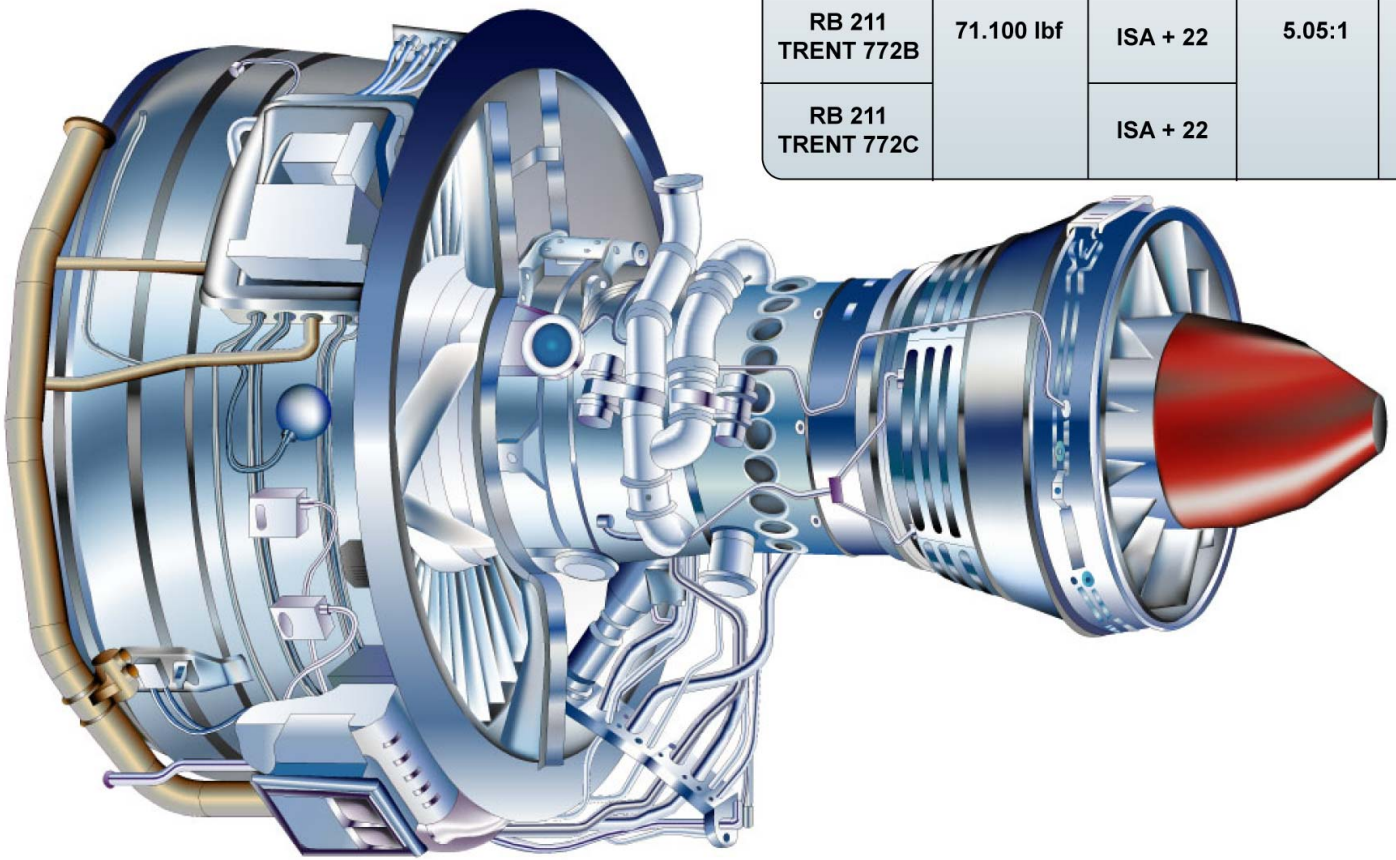
ENGINE	MAX THRUST RATING	FLAT RATED TEMP	BYPASS RATIO	DRY WEIGHT
RB 211 TRENT 772	71.100 lbf	ISA + 15	5.05:1	6 160 Kg (13.580 lb)
RB 211 TRENT 772B		ISA + 22		
RB 211 TRENT 772C		ISA + 22		



POWERPLANT INTRODUCTION

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

POWERPLANT INSTALLATION

The powerplant installation includes the engine inlet, the engine assembly, the exhaust common nozzle assembly, the fan cowls and thrust reverser assemblies. The FORWARD and AFT engine mounts attach the engine to the aircraft pylon and support the weight of the engine and transmit thrust loads to the aircraft structure.

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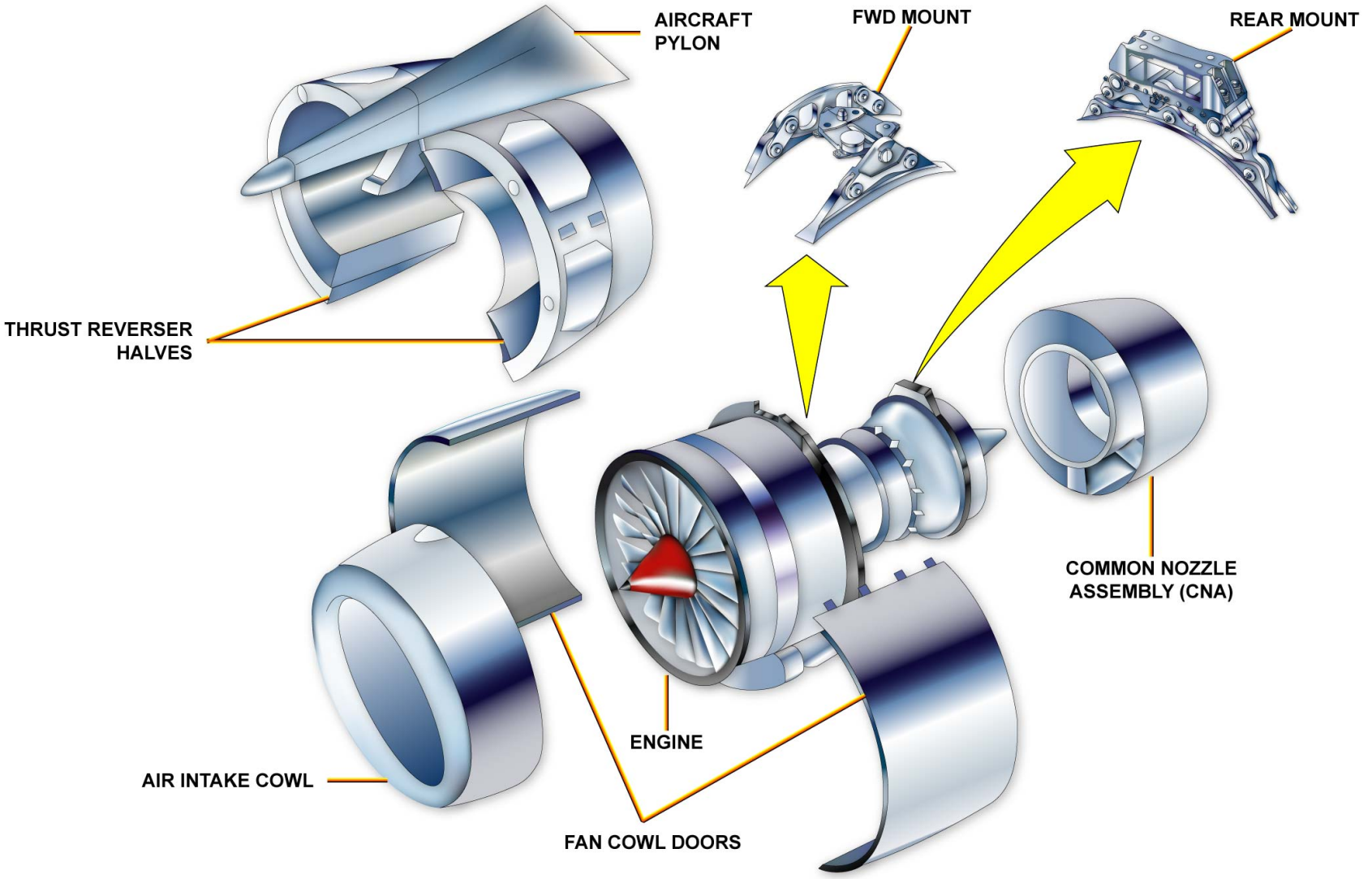

POWERPLANT INSTALLATION

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

MODULAR ENGINE DESIGN

The RR RB-211Trent 772 is designed using a modular concept. The modules may be replaced independently to reduce the time required to return the engine into service. The modules are:
- module 01: LP compressor rotor,
- module 02: IP (Intermediate Pressure) compressor,
- module 03: Intermediate case,
- module 04: HP system (this includes the HP compressor, the combustion system and the HP turbine),
- module 05: IP turbine,
- module 06: External gearbox,
- module 07: LP compressor case,
- module 08: LP turbine.

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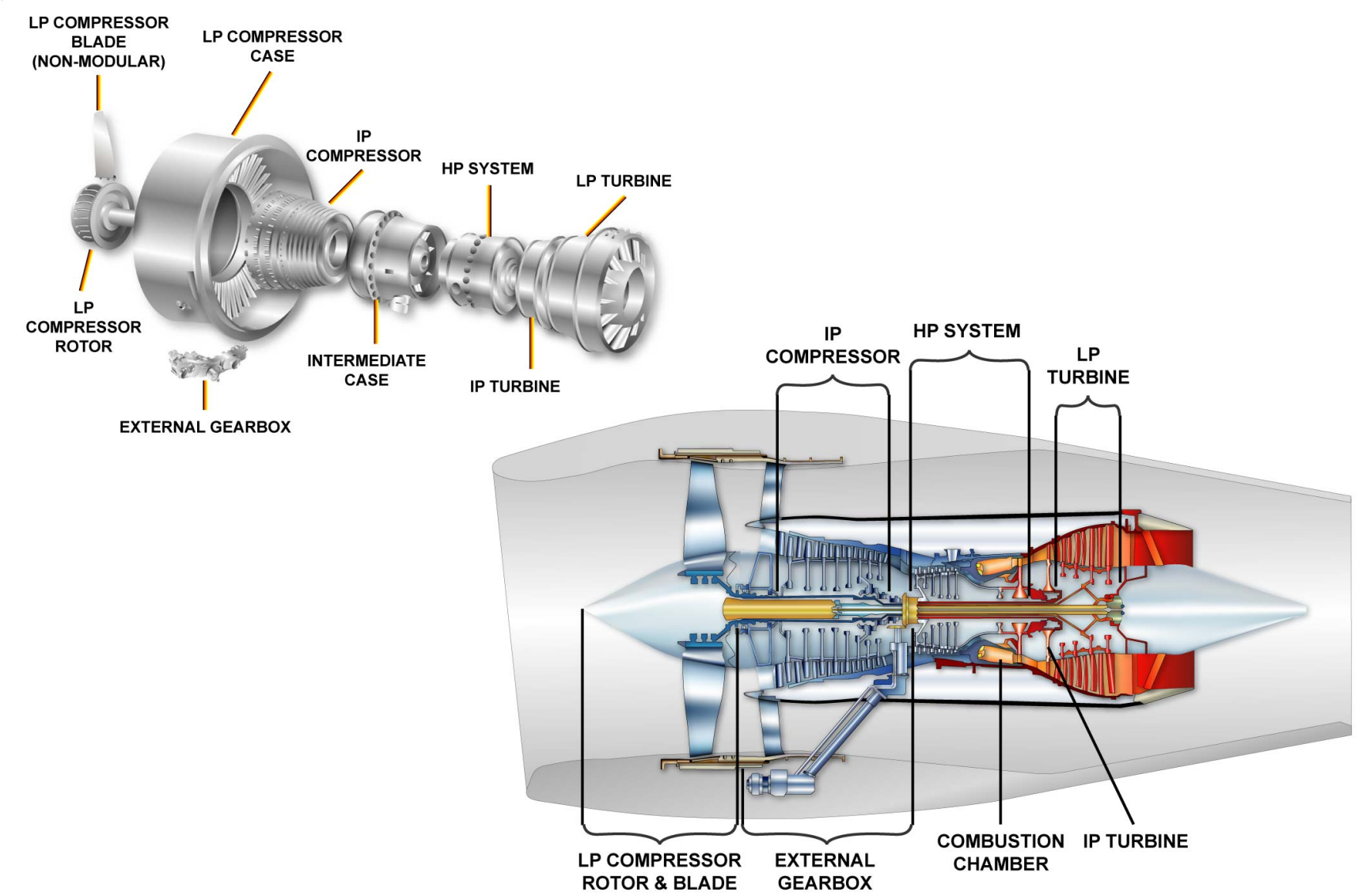

MODULAR ENGINE DESIGN

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

MODULAR ENGINE DESIGN (continued)

LP ROTOR

The LP rotor has the forward fan and the LP shaft, all driven by the 4-stage LP turbine. The speed of the LP rotor is indicated on ECAM as N1. The forward fan supplies most of the engine thrust. The air produced by the fan is known as secondary airflow or bypass airflow. The air, which goes through the engine core for combustion is the primary airflow. The LP (fan) compressor case features a Kevlar containment band designed to protect the fuselage by helping to prevent any fan blade damage within the nacelle.
The LP Turbine Case is the location for the rear engine mount. The LP rotor is supported by 2 ball and 2 roller bearings, which are lubricated and cooled.

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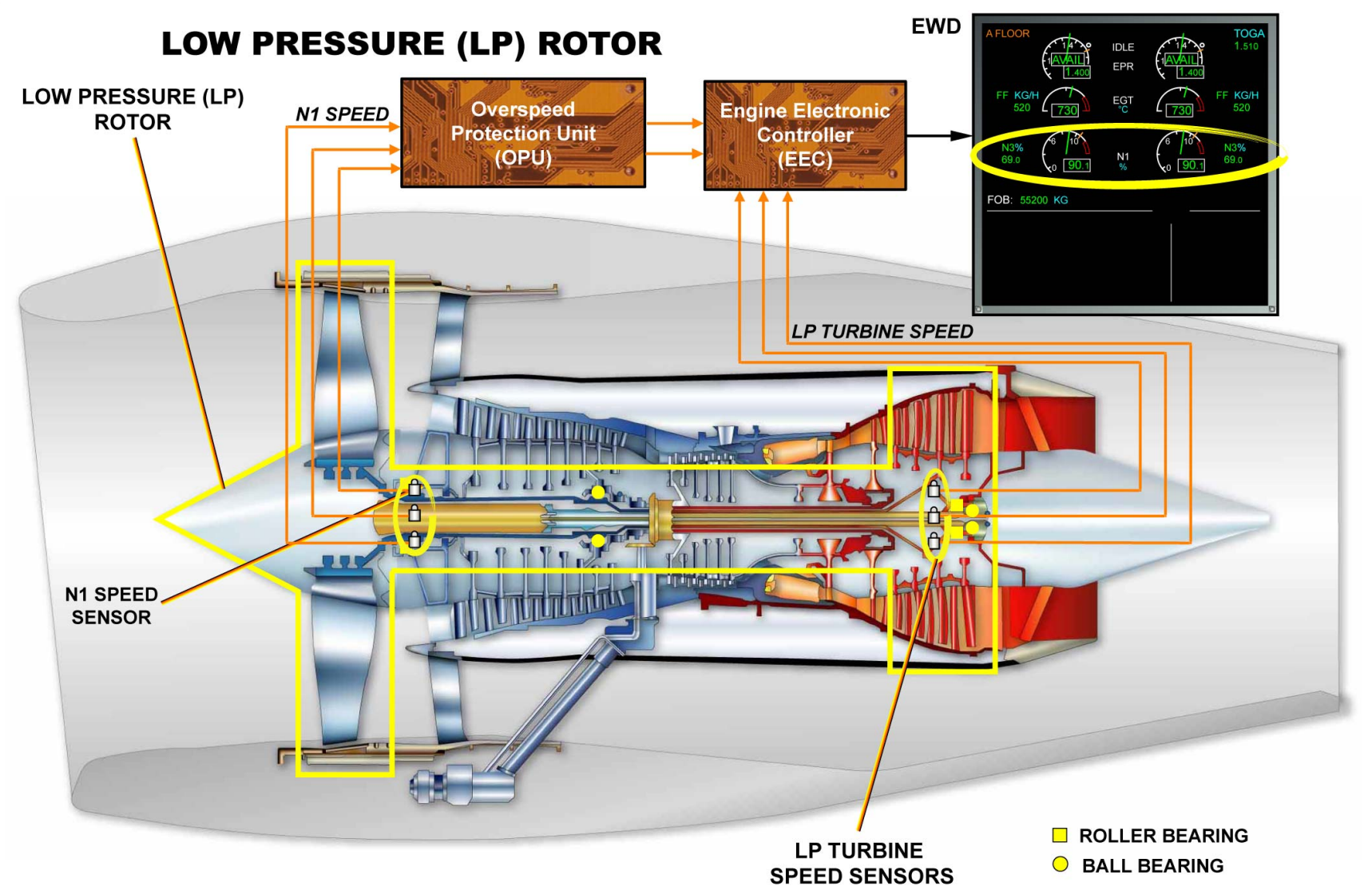

MODULAR ENGINE DESIGN - LP ROTOR

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

MODULAR ENGINE DESIGN (continued)

IP ROTOR

The IP rotor has an 8-stage IP compressor driven by a single-stage IP turbine. The IP compressor supplies primary airflow to the high-pressure compressor for combustion. The speed of the IP rotor is indicated on the ECAM as N2.
1 ball and 2 roller bearings support the IP rotor and are lubricated and cooled. The Intermediate case is the location for the forward engine mount.

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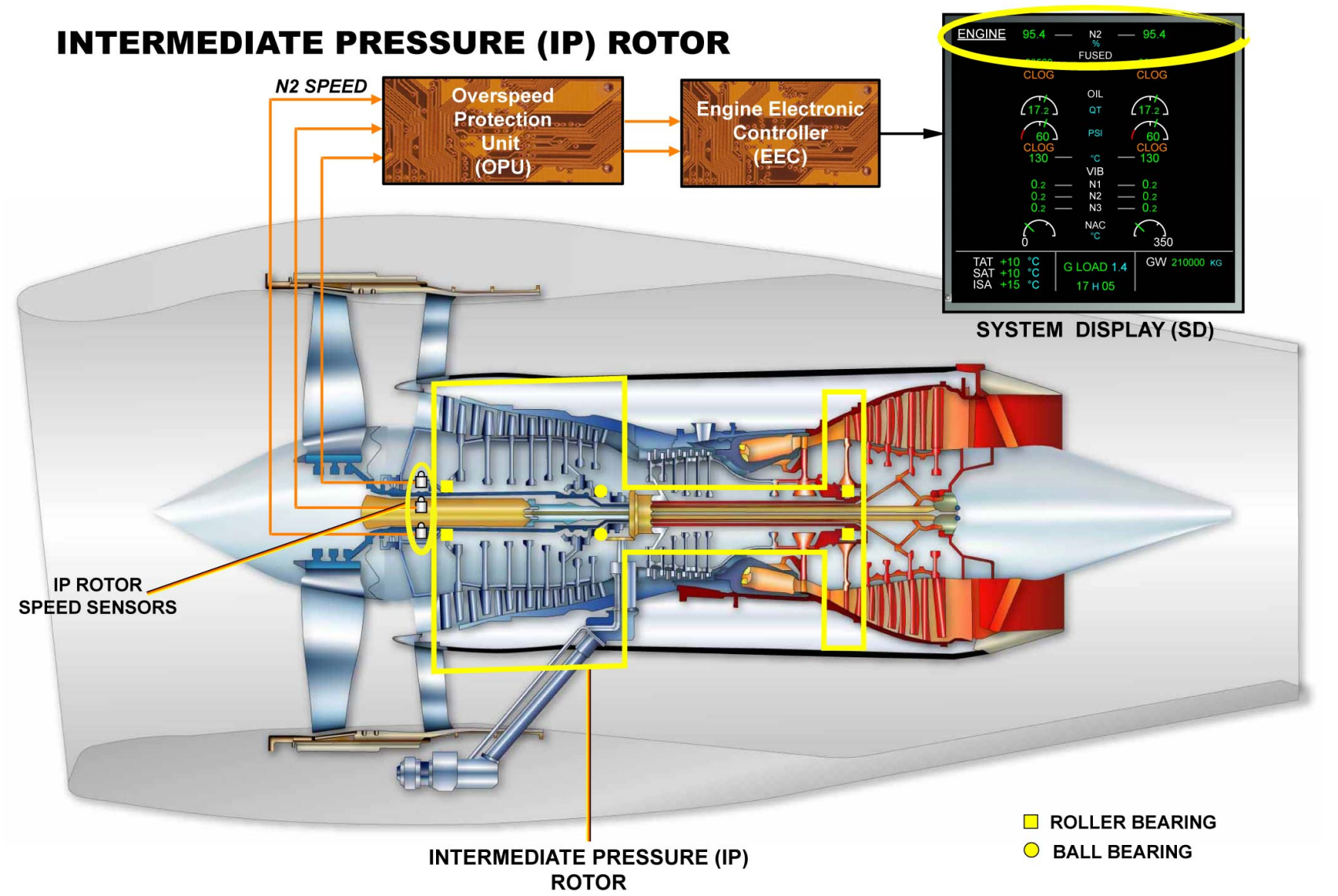

MODULAR ENGINE DESIGN - IP ROTOR

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

MODULAR ENGINE DESIGN (continued)

HP ROTOR

The HP rotor is made of a 6-stage HP compressor driven by a single-stage HP turbine. The HP compressor is also the source of customer bleed air. The speed of the HP rotor is indicated on the ECAM as N3. The HP rotor is supported by 1 ball and 1 roller bearing, which are lubricated and cooled.
The annular combustion chamber is installed between the HP compressor and HP turbine. It has ports for 24 fuel nozzles and 2 igniter plugs.

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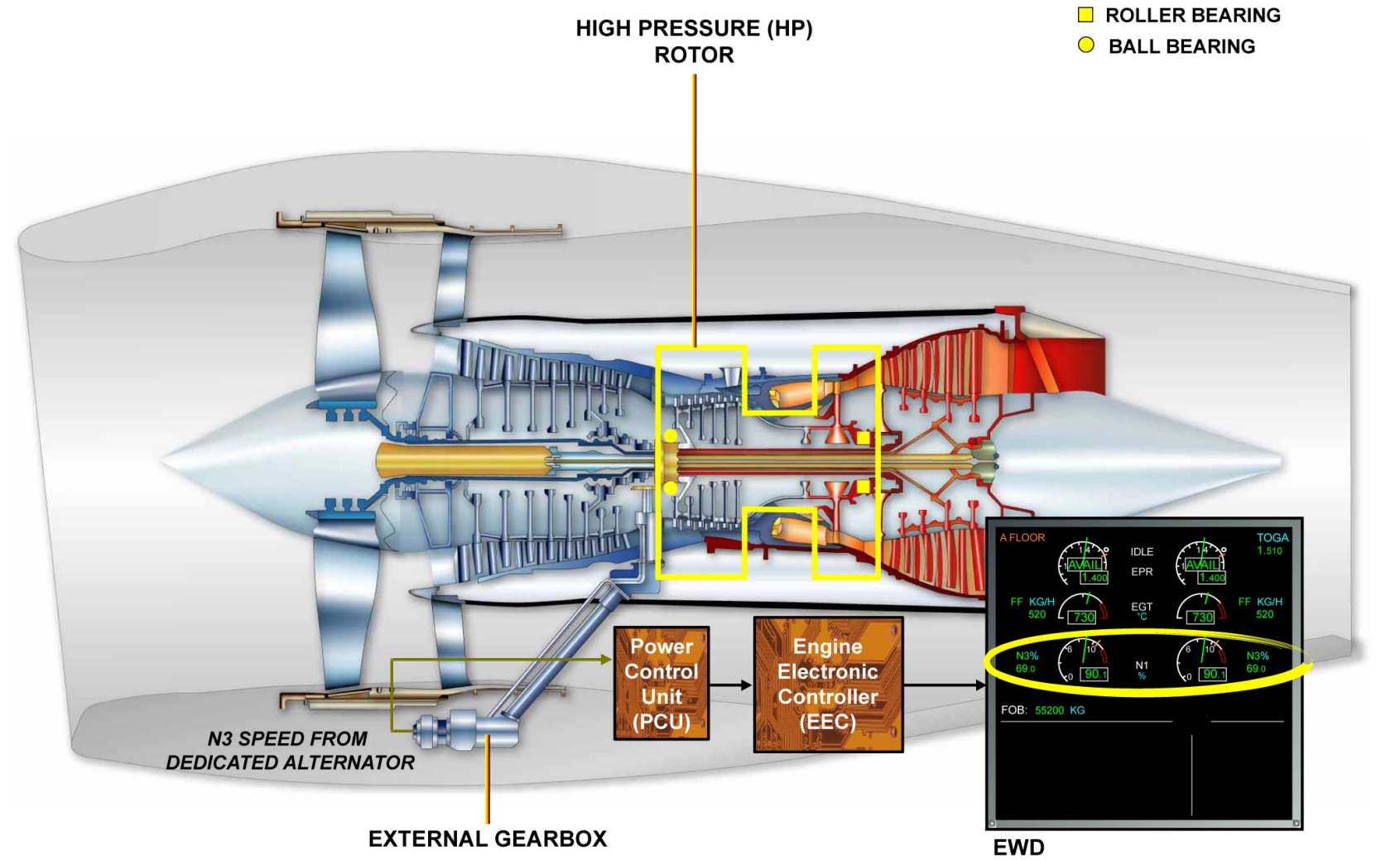
HIGH PRESSURE (HP) ROTOR



MODULAR ENGINE DESIGN - HP ROTOR

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MODULAR ENGINE DESIGN (continued)

ACCESSORY DRIVE

The external gearbox is attached to the bottom of the LP compressor case and is driven by the HP rotor through an internal gearbox. The fuel pump, oil pump assembly, hydraulic pumps, Integrated Drive Generator (IDG) and the Electronic Engine Controller (EEC) Dedicated Alternator are all attached to and driven by the external gearbox.

The starter is also attached to the external gearbox. During engine starting, the starter rotates the HP compressor through the external and internal gearboxes.

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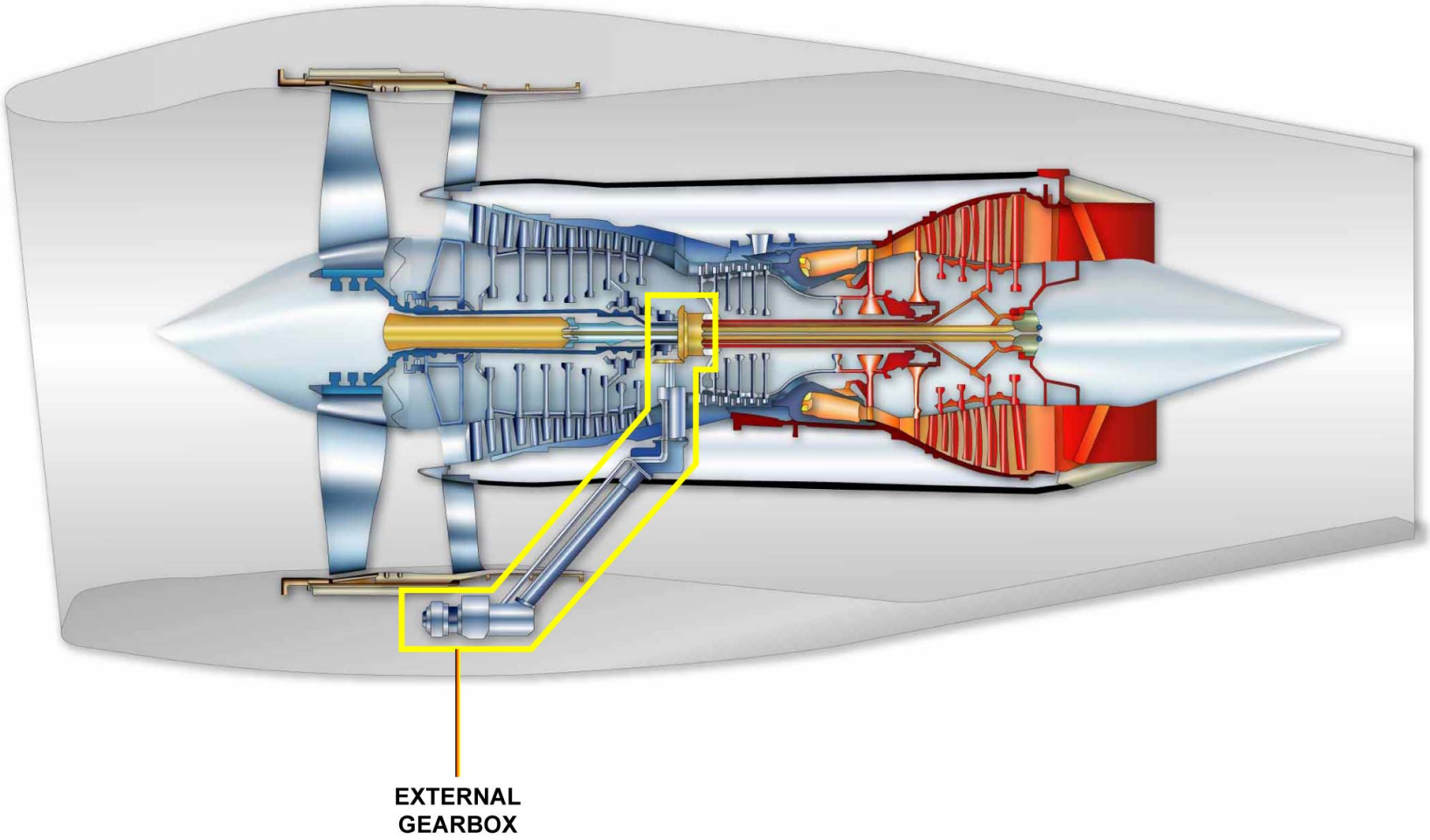

MODULAR ENGINE DESIGN - ACCESSORY DRIVE

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FADEC

In order to increase engine reliability and efficiency, the Full Authority Digital Engine Control (FADEC) gives full range of engine control to achieve steady state and transient engine performances when operated in combination with aircraft subsystems.
An EEC and a dual channel computer installed on the engine fan case on the left hand side, control each engine. The EEC controls the engine during start and all operations. The EEC manages engine thrust and protects against overspeed and overtemperature by controlling the engine sub-systems. The EEC also monitors all engine subsystems and sensors for failure. A The gearbox drives a dual-output EEC Dedicated alternator, which supplies power to the FADEC when the engine is running. The FADEC system has the dual channel EEC and the following peripherals:
- Fuel Metering Unit (FMU),
- EEC Dedicated Alternator,
- compressor control systems (Variable Stator Valve (VSV), IP / HP Bleed Valves),
- turbine Impingement Cooling system (TIC),
- start system (starter shutoff valve, ignition exciters),
- thrust Reverser system,
- engine sensors,
- electrical harnesses.

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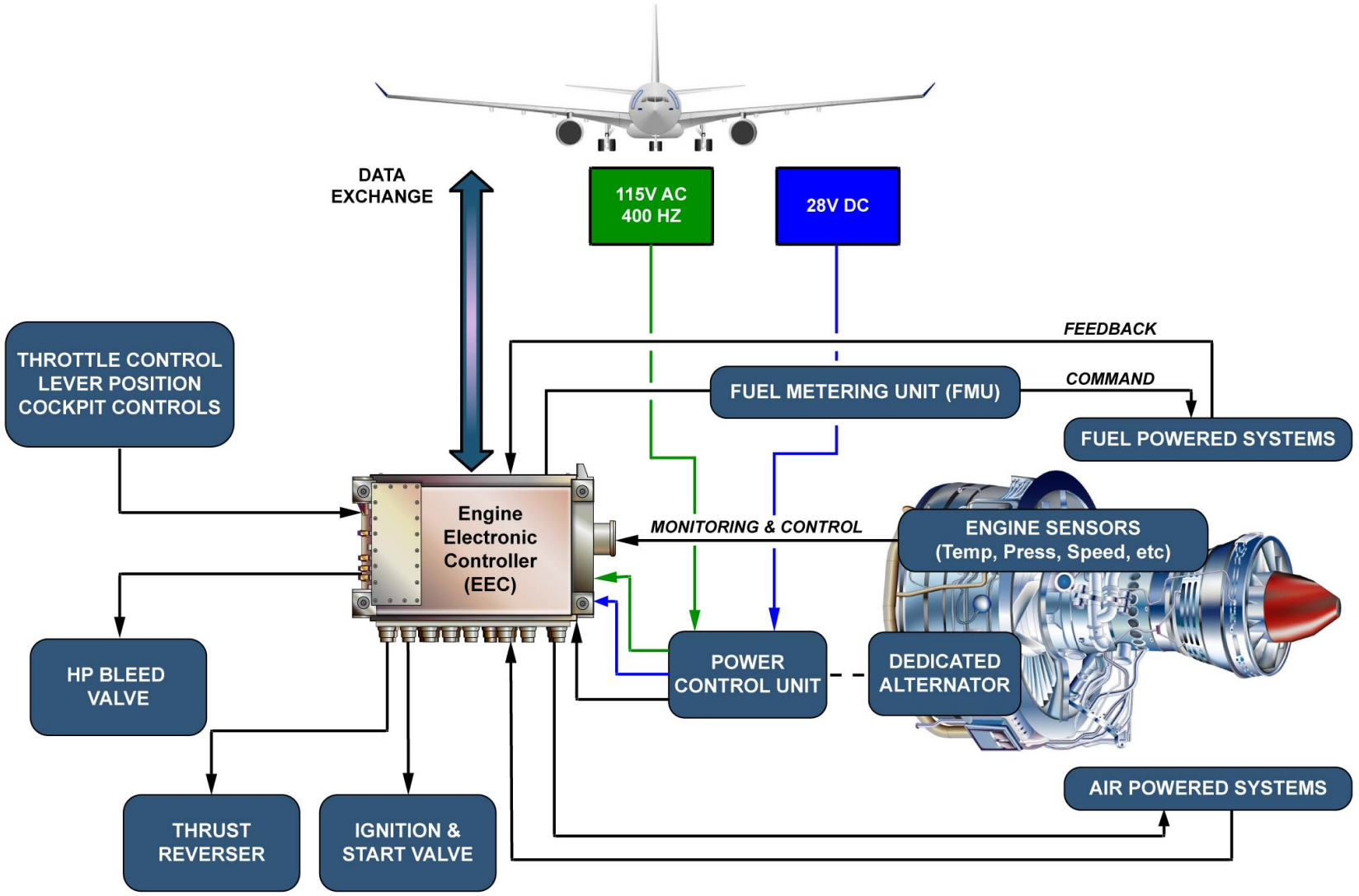
DATA EXCHANGE
115V AC 400 HZ
28V DC
FEEDBACK
THROTTLE CONTROL LEVER POSITION COCKPIT CONTROLS
FUEL METERING UNIT (FMU)
COMMAND
FUEL POWERED SYSTEMS
Engine Electronic Controller (EEC)
MONITORING & CONTROL
ENGINE SENSORS (Temp, Press, Speed, etc)
HP BLEED VALVE
POWER CONTROL UNIT
DEDICATED ALTERNATOR
AIR POWERED SYSTEMS
THRUST REVERSER
IGNITION & START VALVE

FADEC

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

ENGINE INTERFACE AND VIBRATION MONITORING UNIT (EIVMU)

The EEC interfaces with various aircraft systems. Essential communication with the EEC (thrust lever position, air data, ECAM Primary indications, etc.) is direct to and from the applicable systems and controls. Non-essential communication (autothrust, start sequence identification, Central Maintenance System (CMS), etc) is routed through the Engine Interface and Vibration Monitoring Unit (EIVMU) of each engine. The EIVMUs interface with various aircraft circuits and systems. The data is then transmitted in a single stream to each EEC channel.
Engine vibration monitoring is also accomplished by the EIVMU. Each EIVMU collects vibration data from the vibration sensor on the engine. The vibration information is displayed on the ECAM and is also available through the CMS for troubleshooting.
The aircraft systems use engine running, starting status for different logics related to their operations.

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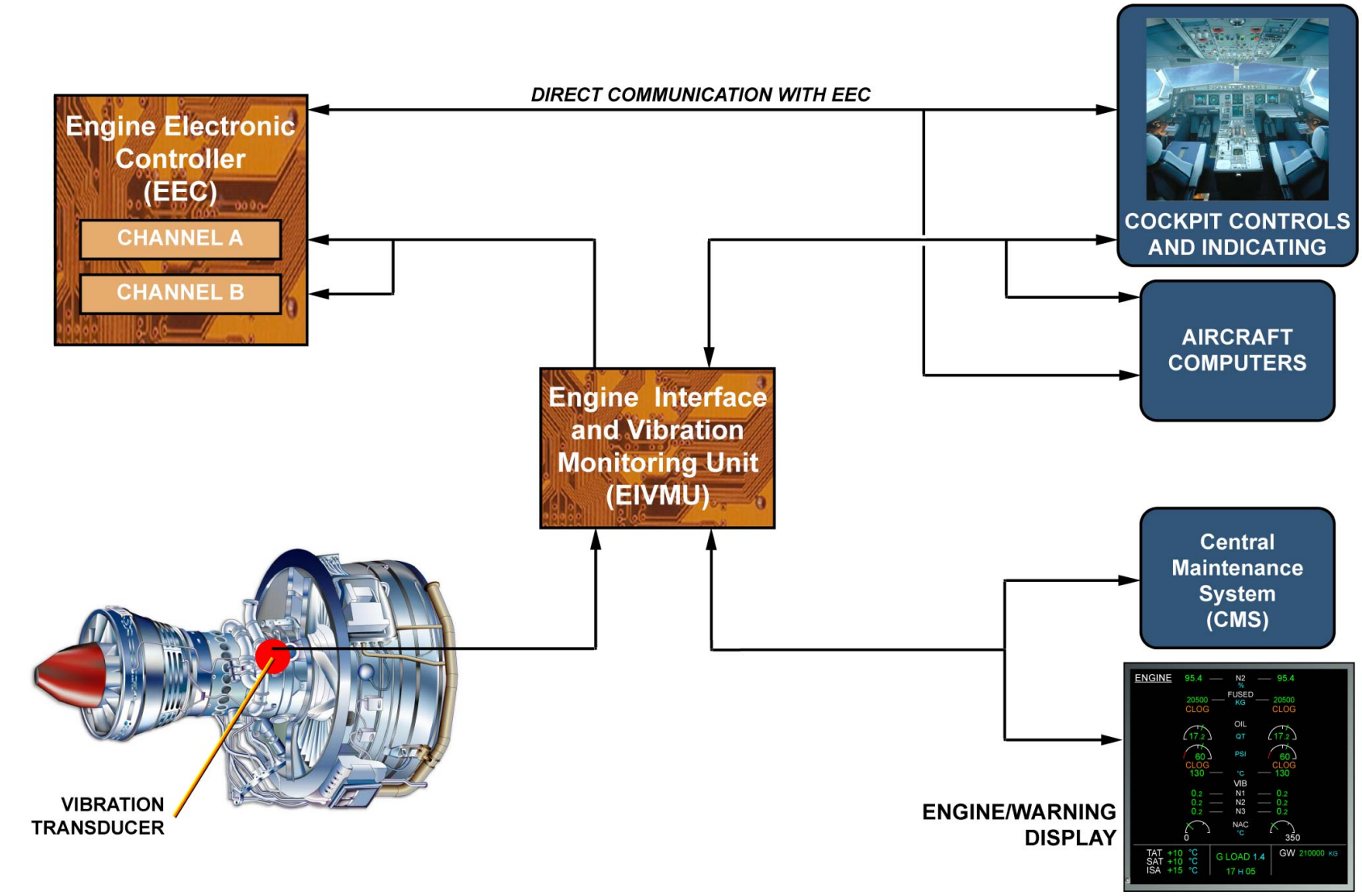

ENGINE INTERFACE AND VIBRATION MONITORING UNIT (EIVMU)

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

ENGINE FUEL SYSTEM

The engine fuel system is designed to supply metered fuel to the combustion chamber according to the engine power demand. The fuel system is also used to cool the engine oil and supply servo pressure to operate valves and actuators.
The Engine Electronic Controller (EEC) controls the operation of the engine fuel system. The EEC also monitors the system for normal operation and ECAM fuel flow indication.

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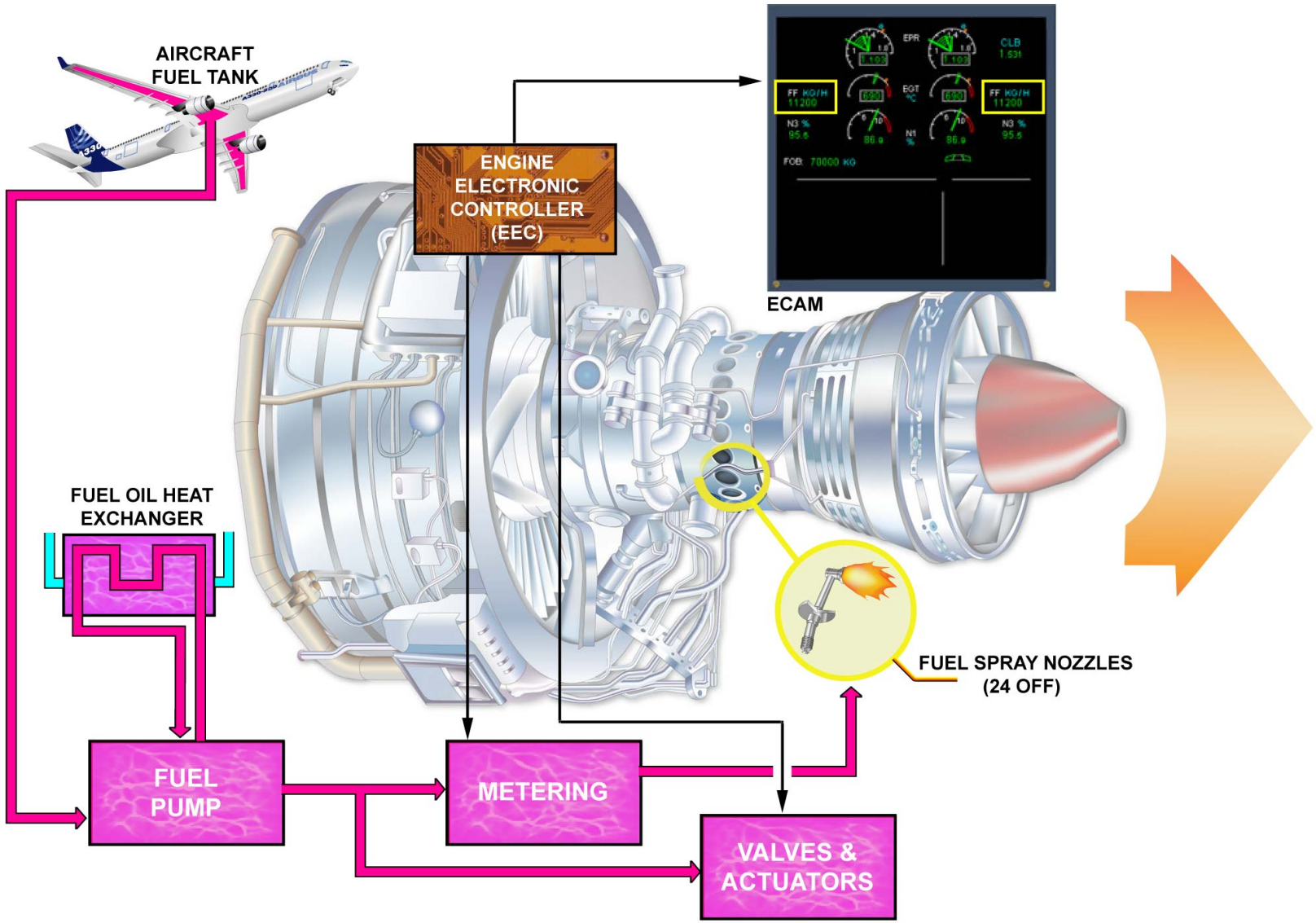

ENGINE FUEL SYSTEM

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

OIL SYSTEM

The primary function of the oil system is to supply sufficient oil at the correct temperature and pressure to the engine internal drives, gears and bearings for lubrication, to decrease temperature and keep wear to a minimum. The oil system is also designed to heat the fuel to prevent fuel icing.

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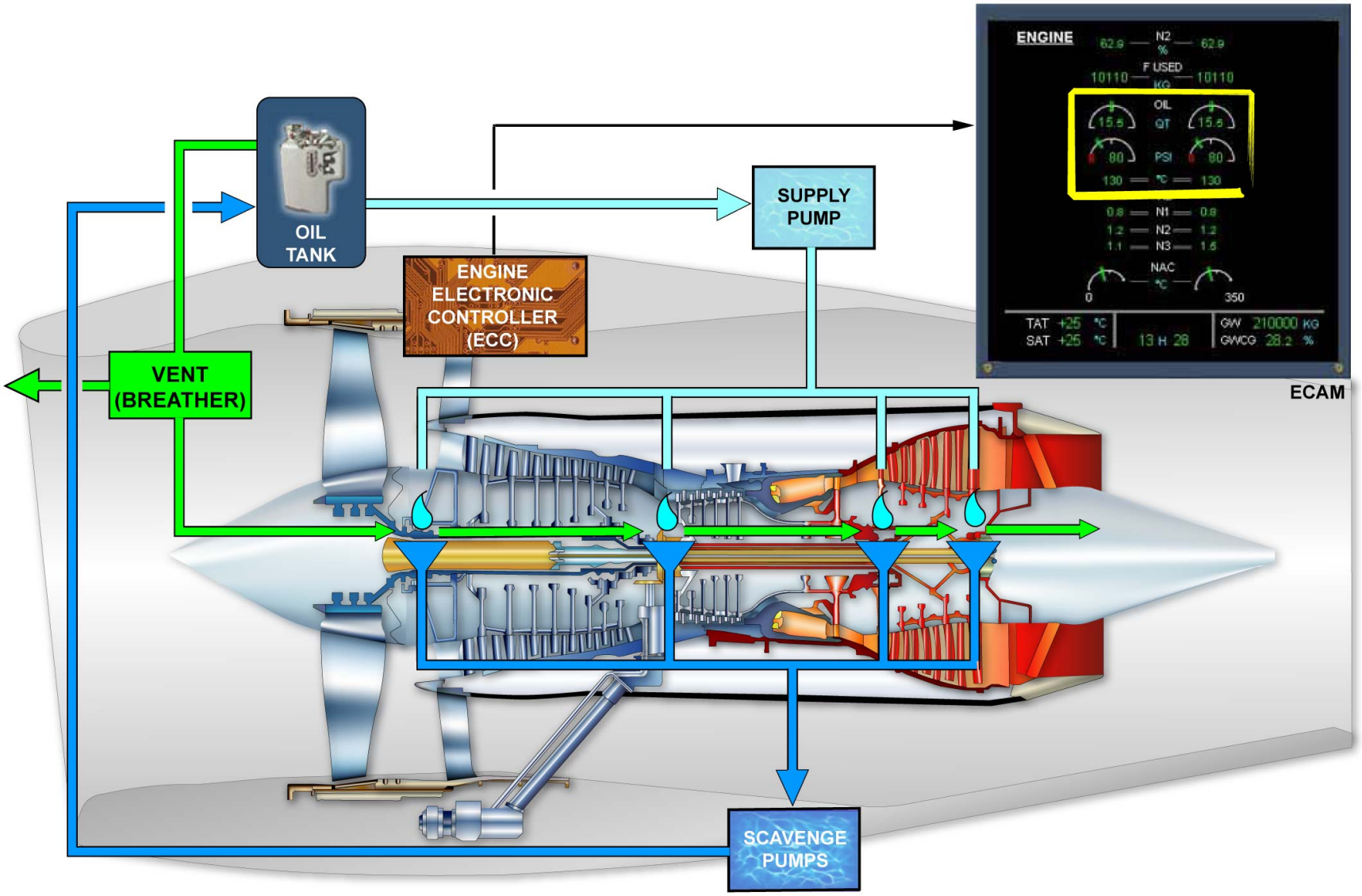
OIL TANK
SUPPLY PUMP
ENGINE ELECTRONIC CONTROLLER (ECC)
VENT (BREATHER)
SCAVENGE PUMPS
ENGINE
N2
F USED
OIL
QT
PSI
N1
N2
N3
NAC
TAT +25 °C
SAT +25 °C
13 H 28
GW 210000 KG
GWCG 28.2 %
ECAM

OIL SYSTEM

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

COOLING AND SEALING SYSTEM

The temperature of the engine is decreased externally with fan air and internally with air supplied from the engine compressors.
Pressurized air is also used to seal the engine bearing chambers to prevent oil leakage.
The Turbine Impingement Cooling (TIC) system controls the turbine blade tip clearances and thus increases the engine performance.
The external temperature is decreased through the Turbine Impingement Cooling system (TIC) with air from the LP compressor (fan air). This system decreases the temperature of the IP and LP turbine cases and decreases the IP turbine blade tip clearance to improve the turbine performance.
The EEC electrically controls the TCC system through a solenoid valve. It is pneumatically operated with HP3 air by an actuator that controls the fan airflow supplied to the turbine cases.
The nacelle cooling system is divided into three zones:
- zone 1, related to the fan case compartment, where the temperature is decreased by external air
- zone 2, related to the intermediate case compartment, where the temperature is decreased by the fan air
- zone 3, related to the core engine compartment, where the temperature is decreased by the fan air.

The air from the fan inlet internally decreases the temperature of the electronic unit protection box. The electronic unit protection box is installed in zone 1 and contains the Engine Electronic Controller (EEC), the Overspeed Protection Unit (OPU) and the Power Control Unit (PCU).

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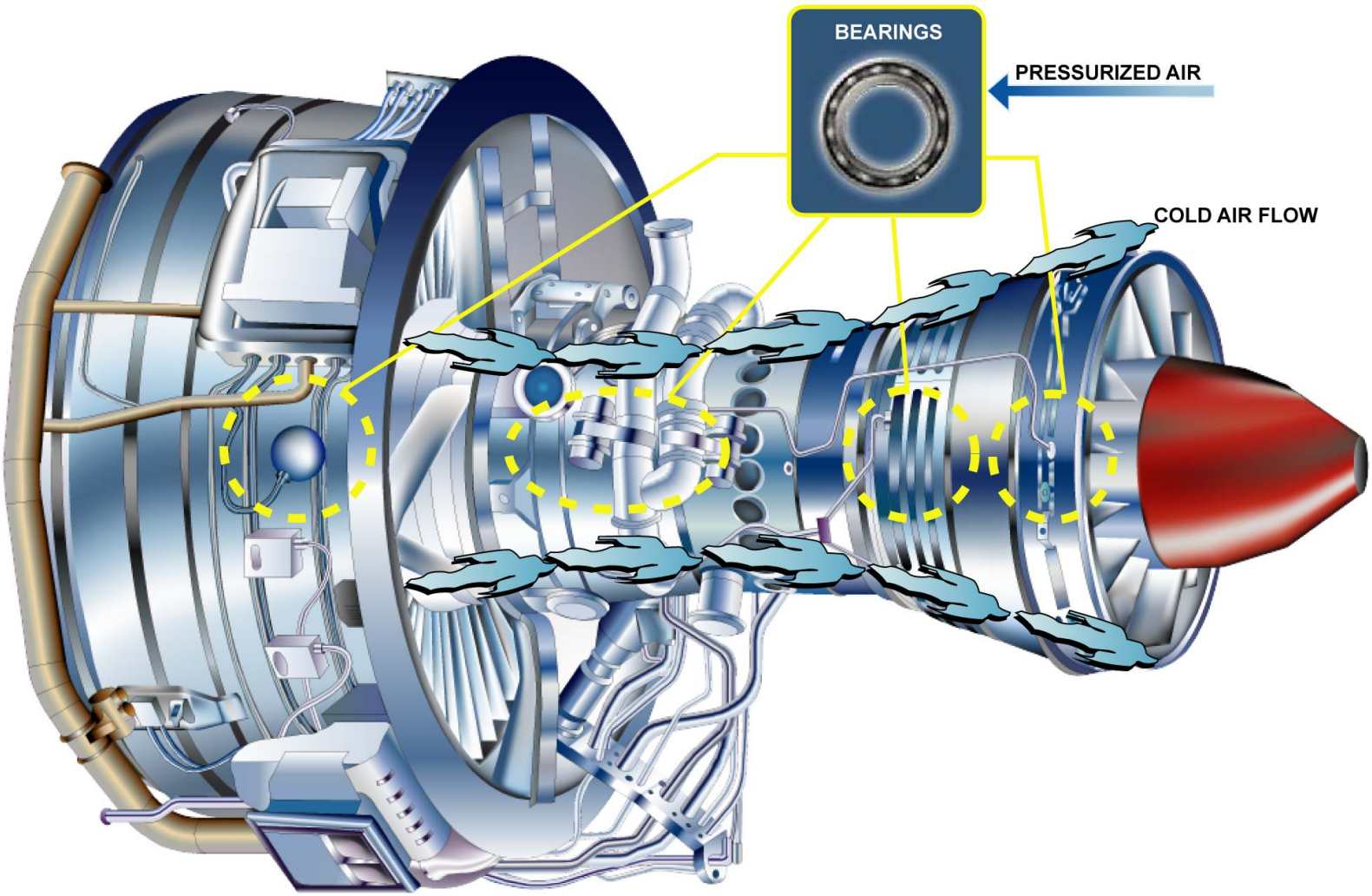

COOLING AND SEALING SYSTEM

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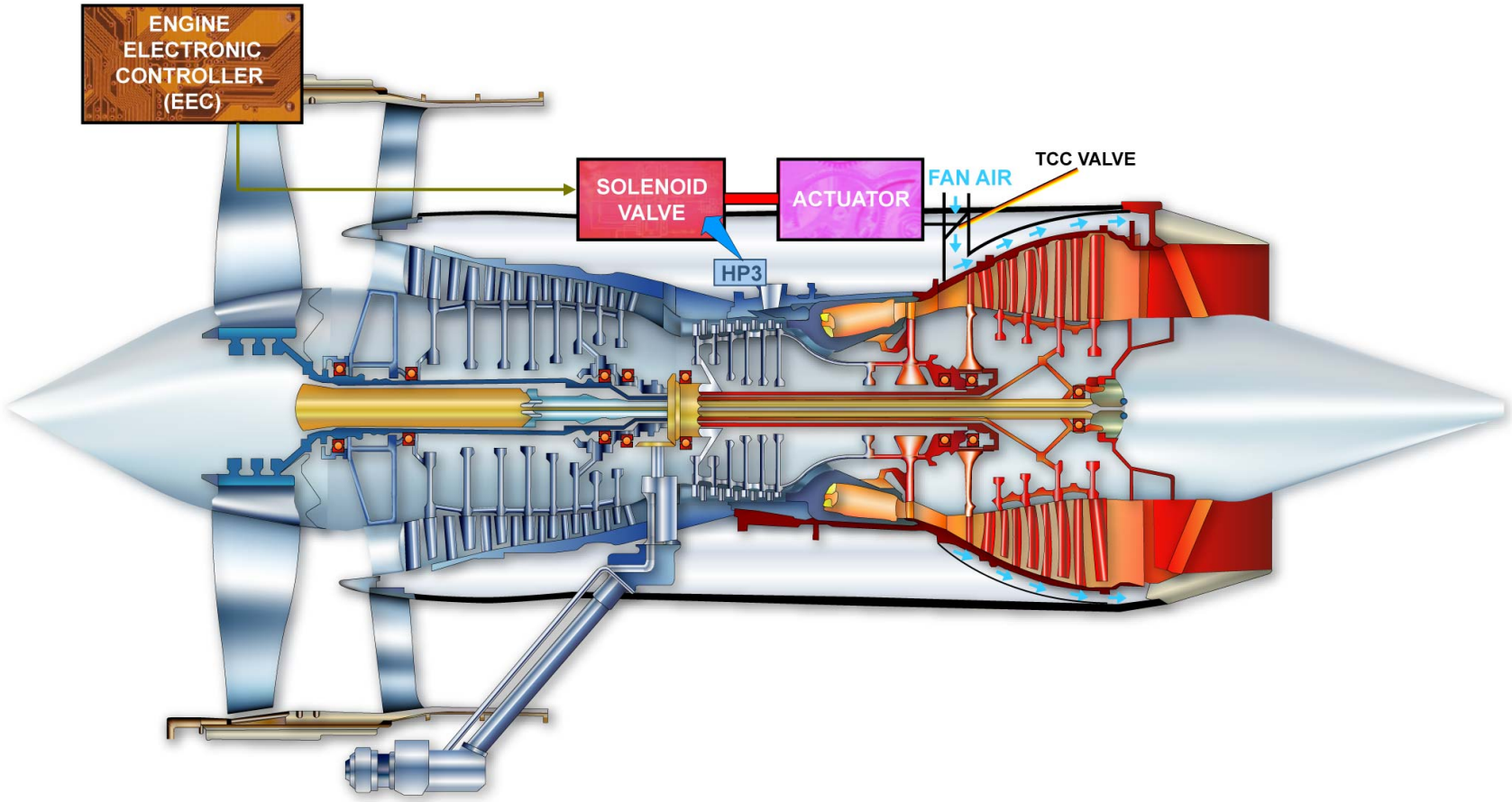

COOLING AND SEALING SYSTEM

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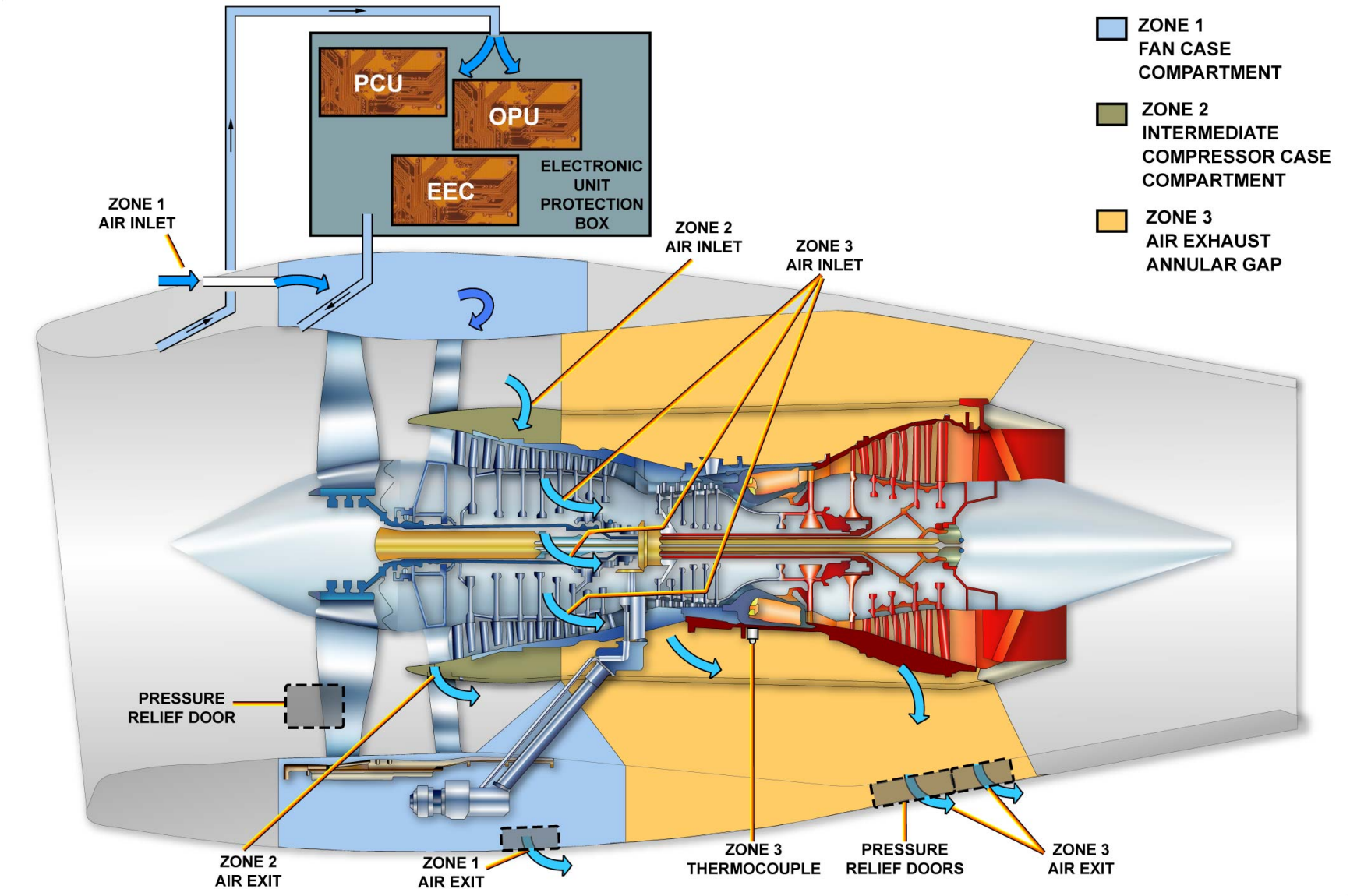

COOLING AND SEALING SYSTEM

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

AIRFLOW CONTROL

The function of the airflow control system is to get a stable airflow through the Intermediate Pressure (IP) and High Pressure (HP) compressors at all thrust ranges to prevent engine stall or surge.
To control the airflow, the system uses:
- Variable Inlet Guide Vanes (VIGVs) and two stages of IP compressor Variable Stator Vanes (VSVs), operated by two fuel-pressure actuators.
- Four IP bleed valves aligned with stage 8 of the IP compressor,
- Three HP bleed valves aligned with stage 3 of the HP compressor. The IP and HP bleed valves are operated by high-pressure air.

The Engine Electronic Controller (EEC) controls the airflow control system.

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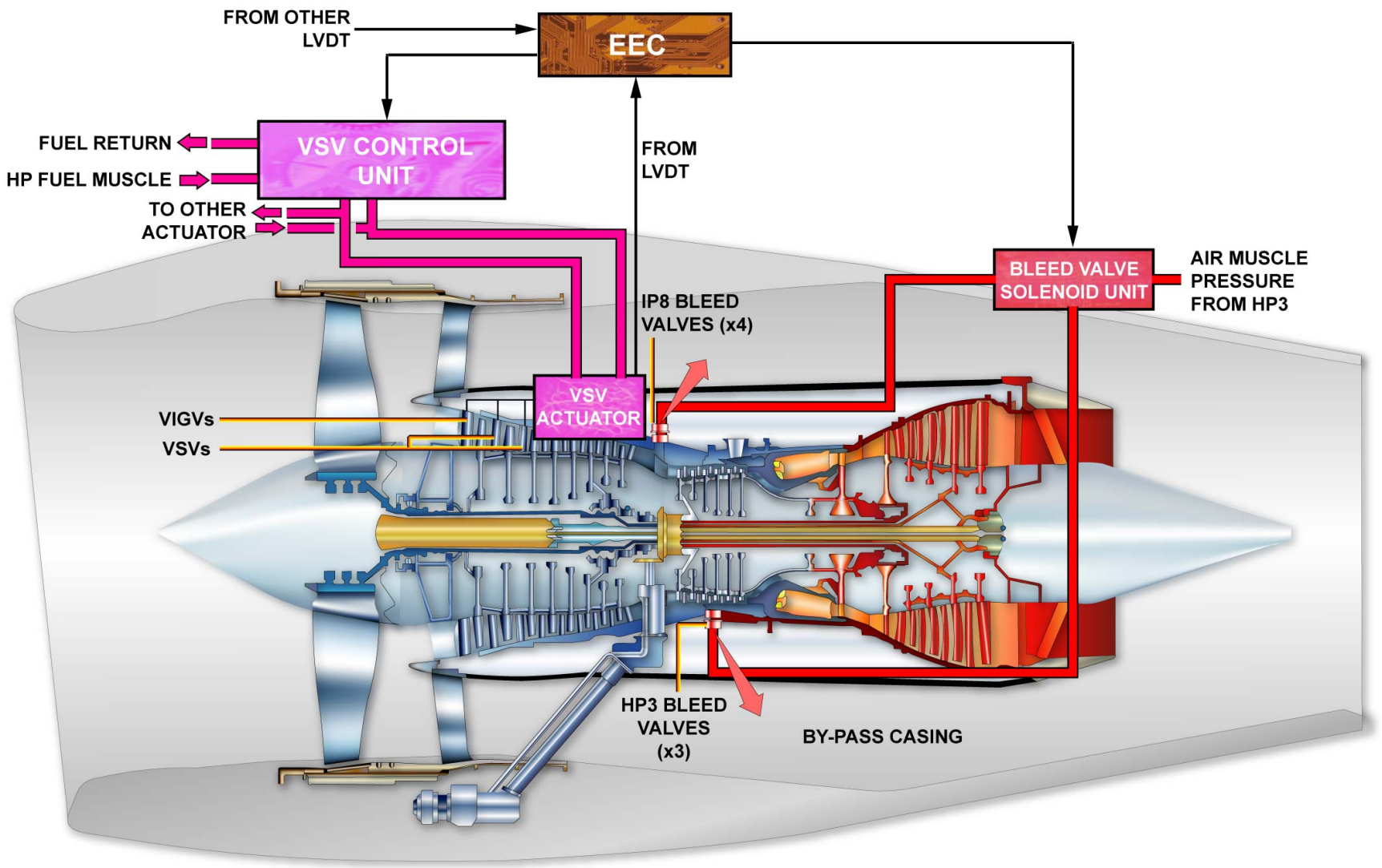

AIRFLOW CONTROL

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THRUST CONTROL SYSTEM

The Engine Electronic Controller (EEC) controls the engine thrust. The engine thrust can be set:
- Manually by the throttle control lever or,
- Automatically by the Auto Flight System (AFS).

The main thrust control parameter is the Engine Pressure Ratio (EPR). The EPR is replaced by N1 (LP rotor) in reverse thrust or in backup mode. The EEC calculates the EPR as a function of the total pressure at the engine inlet P20 and the total pressure at the core engine outlet P50. It is expressed as a ratio: EPR = P50/P20.

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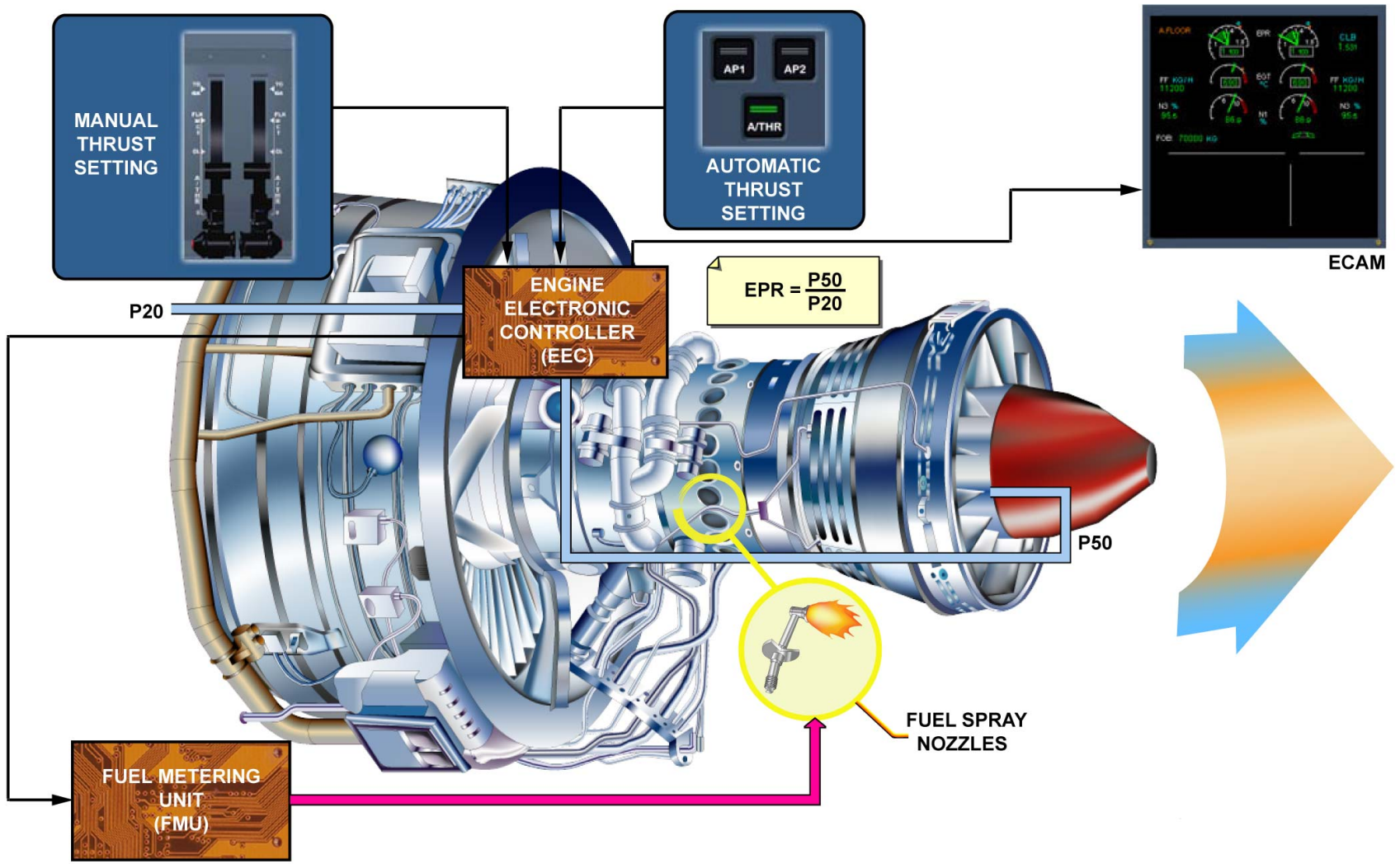

THRUST CONTROL SYSTEM

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

IGNITION AND STARTING SYSTEM

The Engine Electronic Controller (EEC) selects engine starting, motoring and ignition sequences according to digital command inputs from the Engine Interface and Vibration Monitoring Unit (EIVMU). To achieve these functions, the following sub-systems are combined:
- starting,
- fuel,
- ignition.

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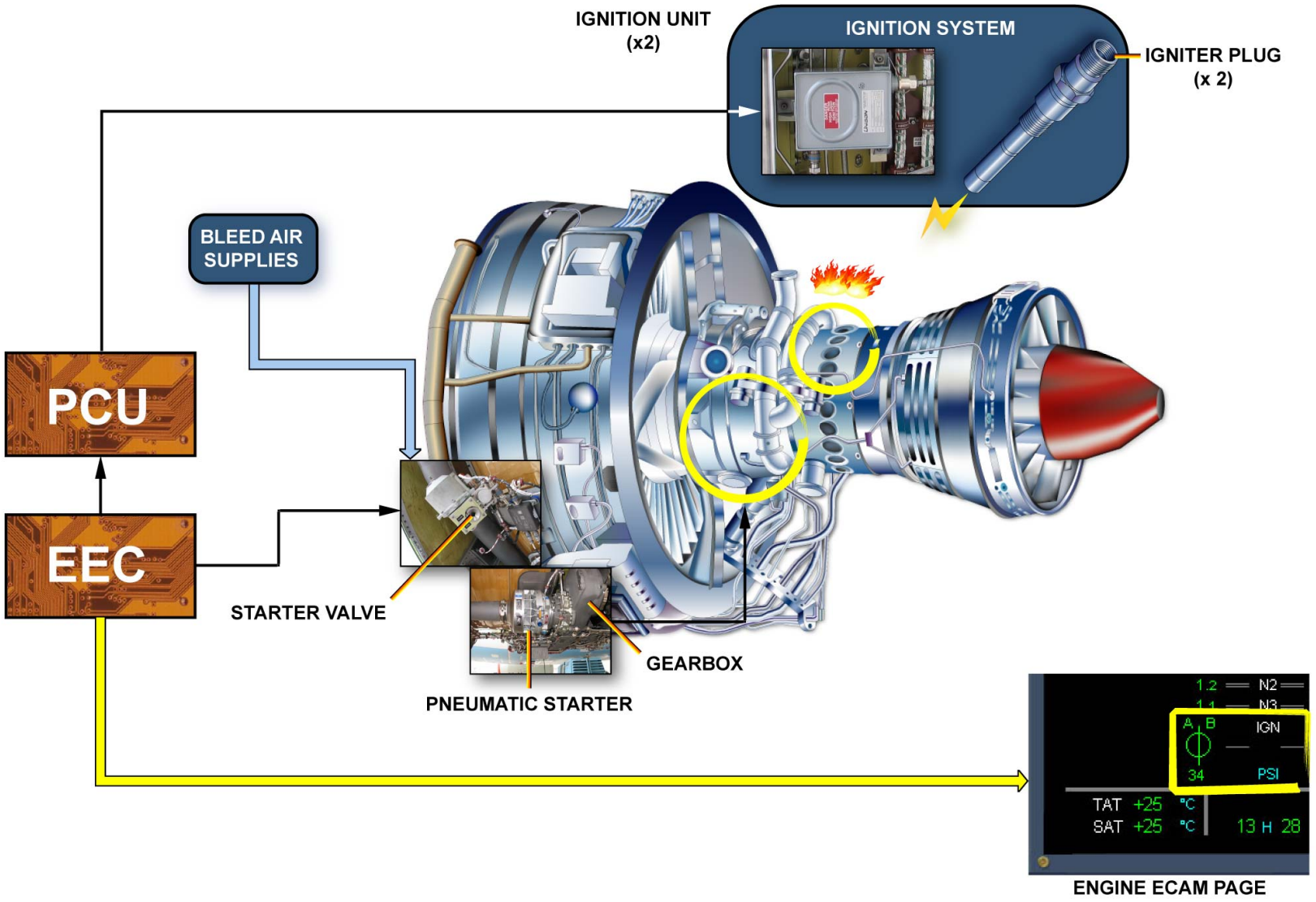

IGNITION AND STARTING SYSTEM

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

THRUST REVERSER SYSTEM

When reverse thrust is selected, 4 pivoting doors open to direct engine thrust. Each half of the thrust reverser includes two pivoting doors. Individual actuators operate these doors. Once the tertiary locks are released, the actuators extend and open the pivoting doors. Reverse thrust is only available on the ground.

The EEC controls the Reverse thrust . The flight crew manually selects the Thrust Reverse by lifting the thrust reverse levers on the throttle control levers. The reversers are deployed using hydraulic pressure. The reverse thrust command is sent to the EEC, the EIVMU and the Flight Control Primary Computers (FCPCs). The EEC operates the thrust reverser isolation valve to supply hydraulic pressure to the system. The EIVMU verifies "aircraft-on-ground" and "thrust reverse selected" and enables the EEC to operate the directional valve. The directional valve directs pressure to unlock the primary locks and extends the actuators to deploy each pivoting door.

An additional layer of protection against inadvertent deployment is the tertiary locking system. Each pivoting door is locked in the stow position by a mechanical lock. The FCPC controls these locks.

The ICU has a deactivation lever. When the lever is operated, it moves a cable that deactivates the ICU for maintenance or dispatch in relation to the Minimum Equipment List (MEL).

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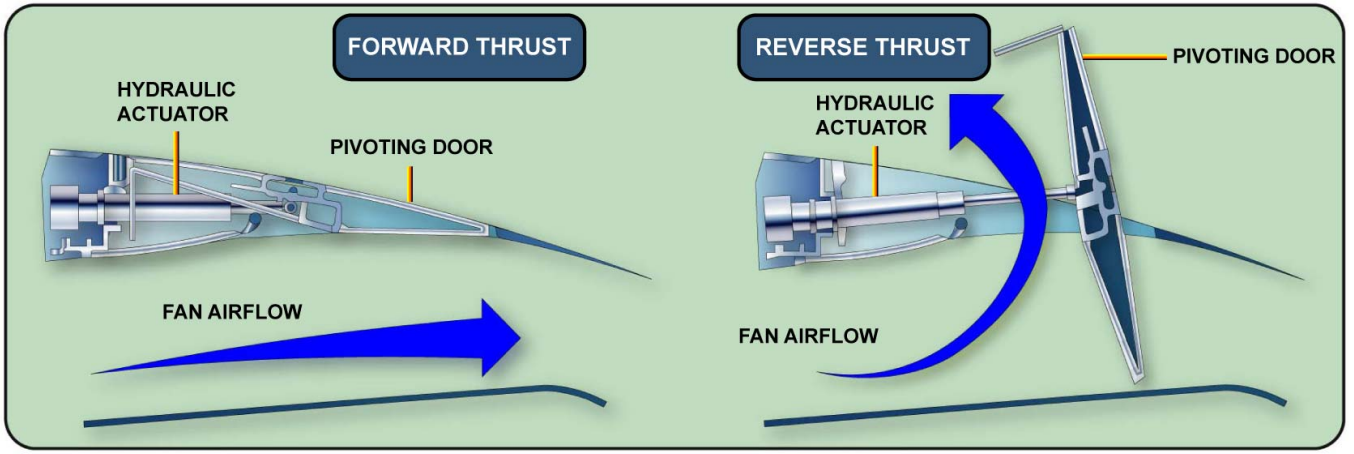
THRUST REVERSERS STOWED

THRUST REVERSERS DEPLOYED



THRUST REVERSER SYSTEM

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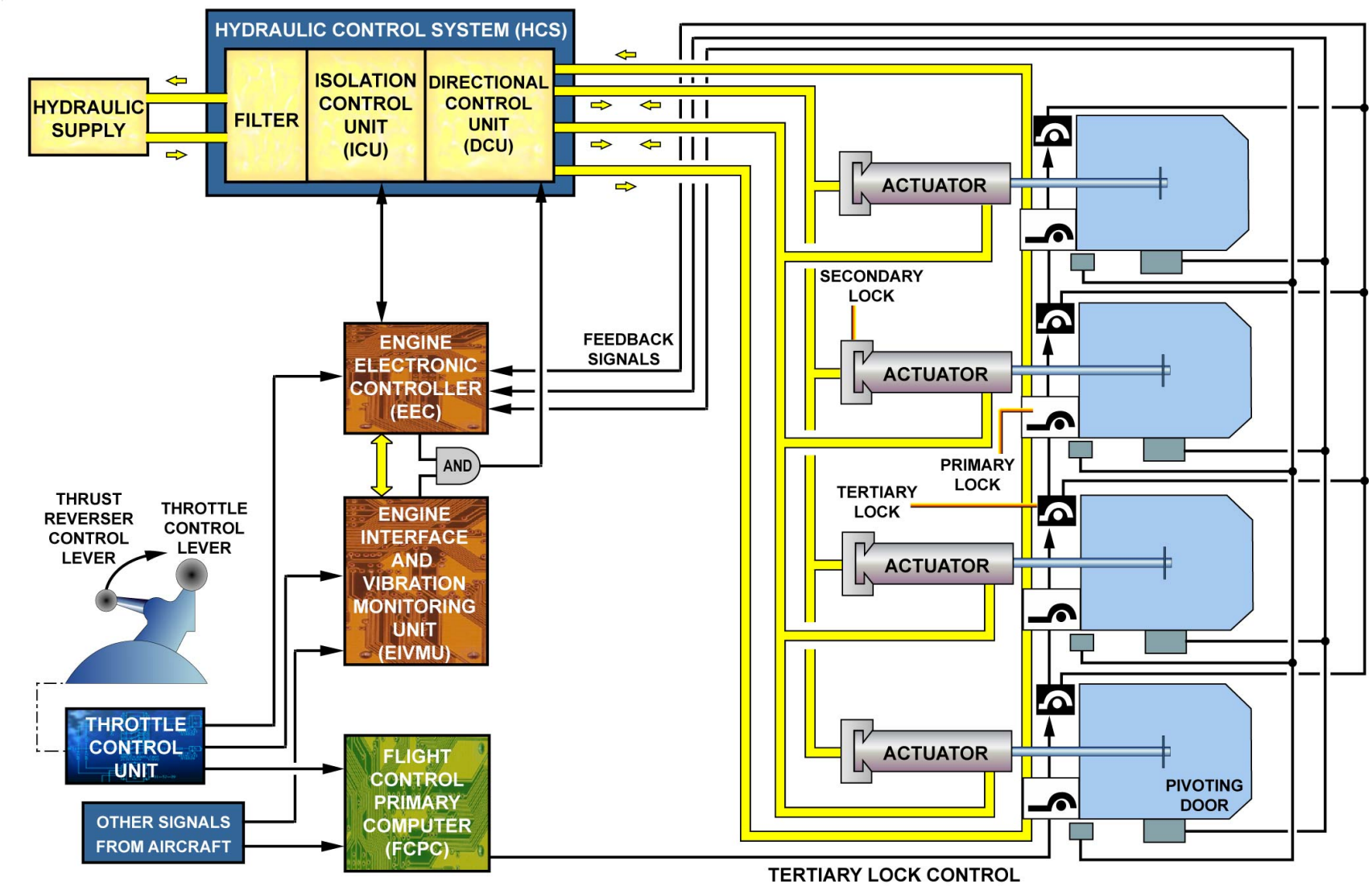

THRUST REVERSER SYSTEM

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

CONTROL AND INDICATING

CONTROL PANELS

The engines are controlled by throttle control levers, which are installed on the center pedestal. They can only be moved manually. To select reverse thrust operation, each throttle control lever includes a reverse thrust control lever. This lever is also used to increase engine power in reverse.
Autothrust mode is the most efficient mode of operation in flight. When active, the autothrust can be disconnected using the two instinctive disconnect pushbuttons. These 2 red buttons are installed on the outside of each throttle control lever. This allows the engines to be controlled in manual thrust mode.
The controls for engine starting and shut down are installed on the center pedestal just behind the throttle control levers. The engine MAN START switches are installed on the overhead panel. These switches are used to initiate an engine manual start procedure. They are also used to initiate an engine dry or wet motoring procedure. The N1 mode switches are used to switch the primary engine control parameter to N1 if the normal EPR control fails.

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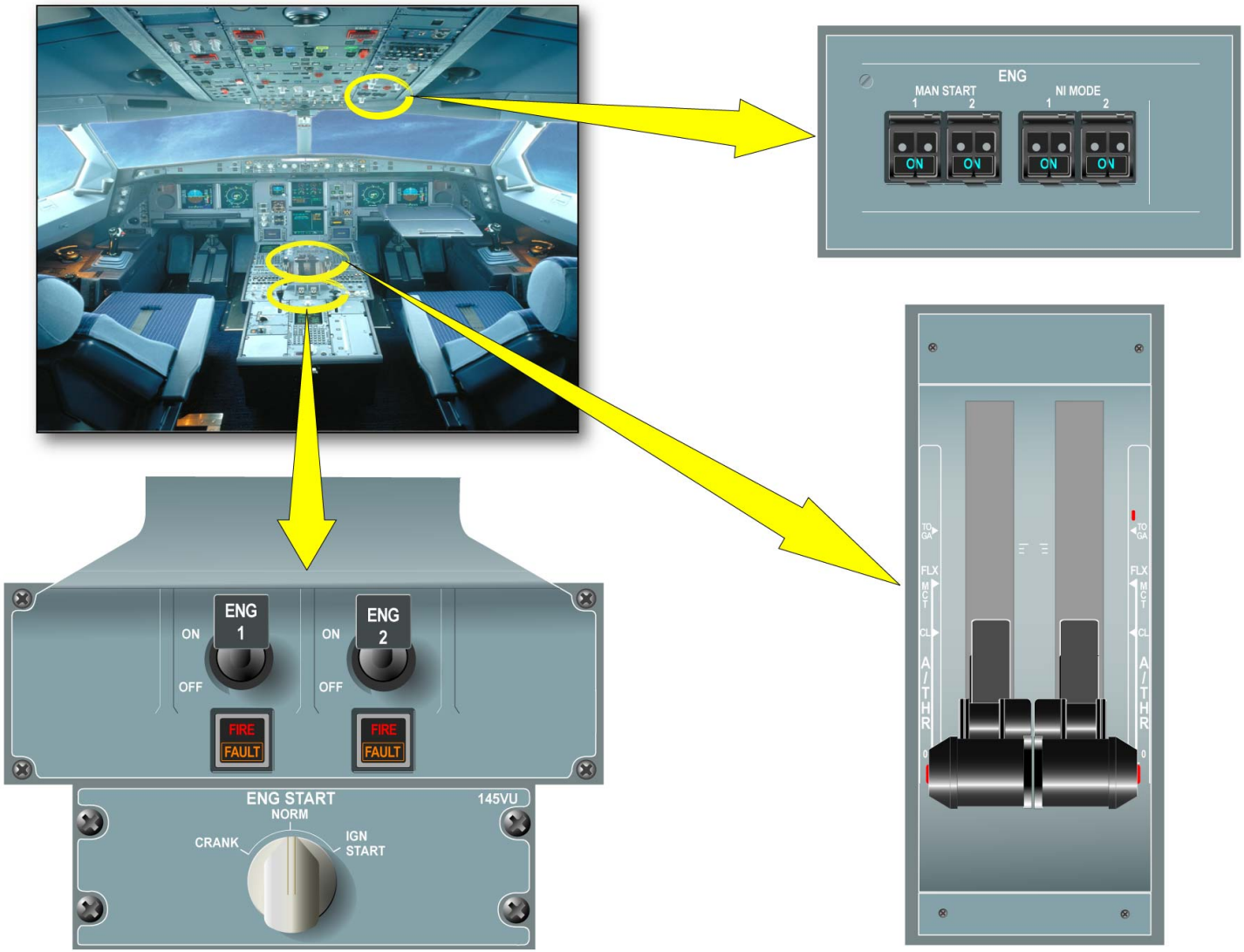

CONTROL AND INDICATING - CONTROL PANELS

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

CONTROL AND INDICATING (continued)

ECAM ENGINE INDICATIONS

The engine primary parameters are permanently displayed on the upper ECAM Engine/Warning Display. The engine secondary parameters are shown on the lower ECAM ENGINE page when it is selected or displayed automatically during an engine start or a fault. Bleed pressure, Starter valve position and ignition are displayed during engine start only. Some engine parameters are permanently displayed on the CRUISE page in flight.

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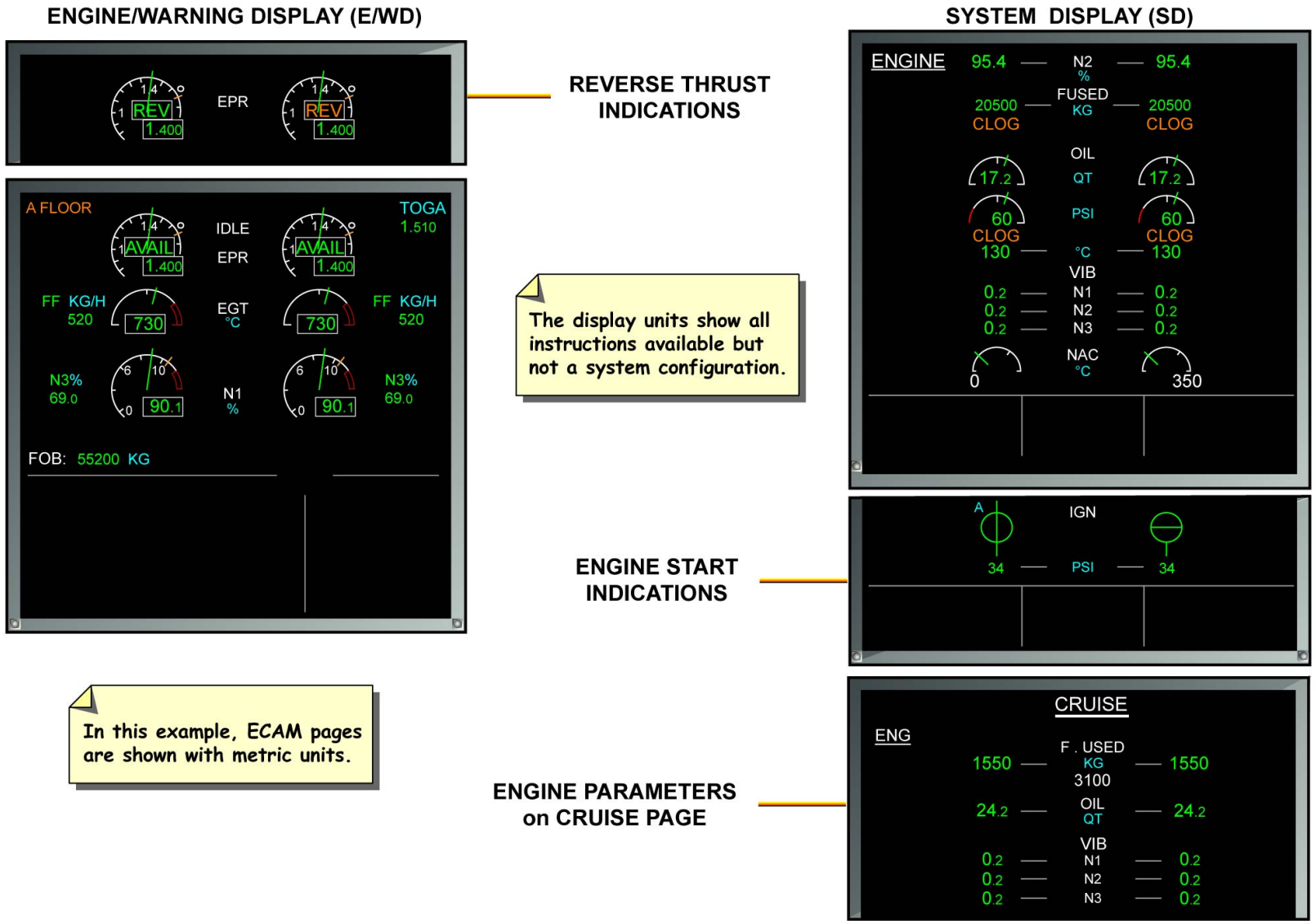

CONTROL AND INDICATING - ECAM ENGINE INDICATIONS

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

MAINTENANCE/TEST FACILITIES

On the maintenance panel, the ENG FADEC GND PWR is used to supply the FADEC system for maintenance tasks, when the engines are not running. The MCDU is used to get access to the CMS f tests and for troubleshooting monitored components (computers, sensors, actuators).

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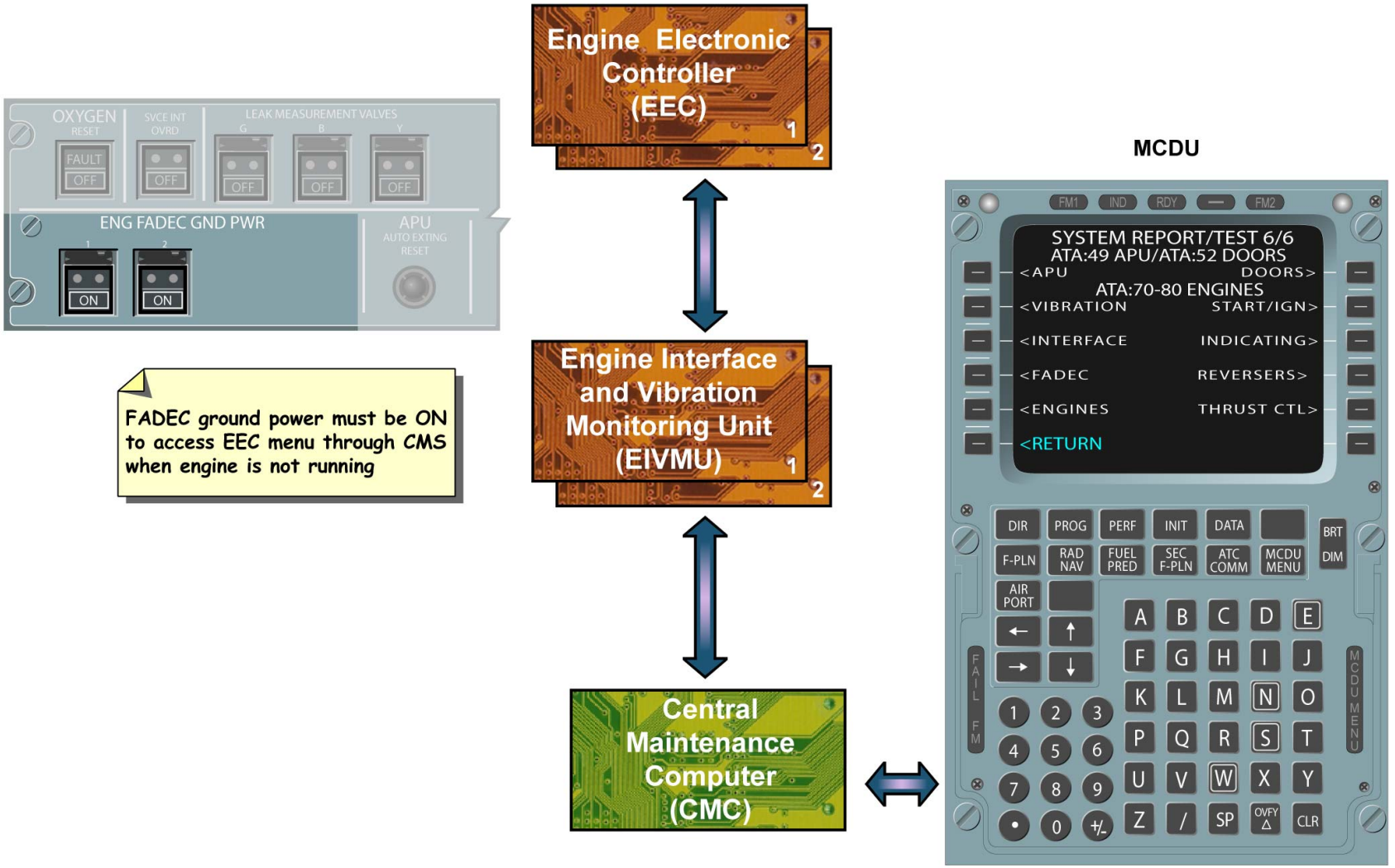

MAINTENANCE/TEST FACILITIES

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

SAFETY PRECAUTIONS

When you work on aircraft, make sure that you obey all the AMM safety procedures. This will prevent injury to personnel and/or damage to the aircraft. Here is an overview of the main safety precautions related to the engines:

- make sure that all engine danger areas are as clear as possible to prevent damage to the engine, the aircraft or personnel in the area,
- make sure that you have fire-fighting equipment available,
- do not try to stop the fan from turning by hand,
- after engine shutdown, let the oil tank pressure bleed off a minimum of 5 minutes before you remove the tank filler cap. If you do not, pressurized oil can spray out of the tank and cause dangerous burns,
- the engine ignition system is an electrical system with high energy. Do not do maintenance on the ignition system while operating the engine. There is a danger of serious electrical shock. Make sure that the engine shutdown occurred a minimum of 5 minutes before you proceed,
- make sure that the thrust reverser is deactivated during maintenance. If not, the thrust reverser can operate accidentally and cause injury to personnel and/or damage to the reverser.

When opening the engine cowls:

- respect the wind limitations and the opening/closing sequence,
- always secure cowls with the hold-open rods,
- make sure that the slats are retracted and install a warning notice to prevent slat operation.

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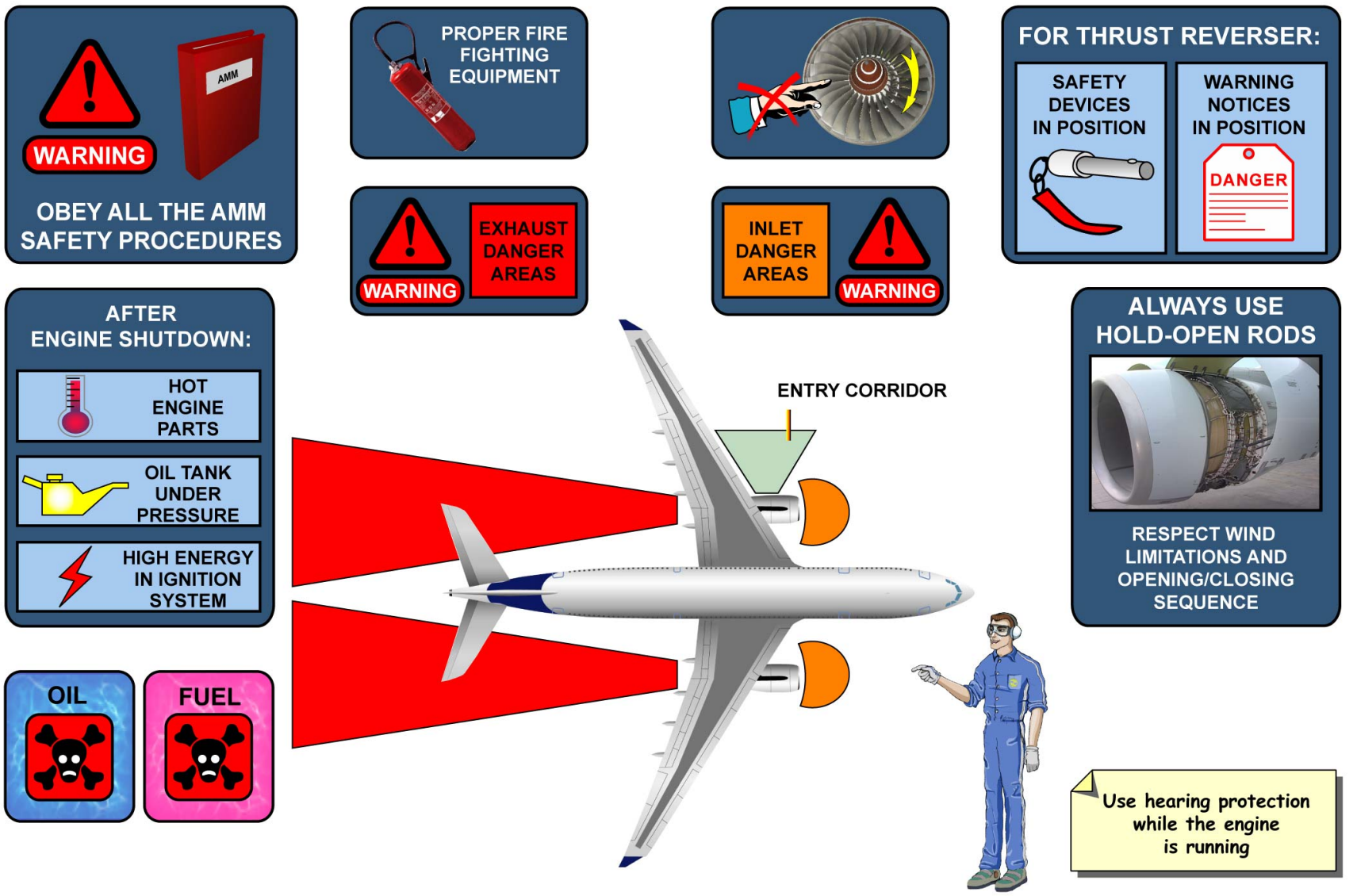

SAFETY PRECAUTIONS

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70 POWER PLANT RR TRENT 700 PRESENTATION (1)

LUBRICANTS AND FUELS

The list of the materials required for the aircraft service and maintenance can be found in the Aircraft Maintenance Manual (AMM), chapter 20 STANDARD PRACTICES or ATA 70 for the engines.

WARNING: ALL SAFETY PRECAUTIONS MUST BE APPLIED.

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AMM ATA 20 STANDARD PRACTICES
20-31-00 LIST OF MATERIALS REQUIRED FOR AIRCRAFT SERVICE AND MAINTENANCE

ITEM	DESIGNATION	MANUFACTURER REFERENCE
.	.	.
.	.	.
.	.	.
01-001	FUEL	JET A-1
01-003	FUEL	JP5
01-004	FUEL	TS1
01-006	FUEL	JP8

AMM ATA 70 STANDARD PRACTICES
70-30-00 (ENGINE) LIST OF MATERIALS
70-02-02 APPROVED ENGINE OILS

List of Approved Engine Oils

(a) Aeroshell Turbine Oil 555 (Royco Turbine Oil 555)

(b) BP Turbo Oil 2197 (formerly Exxon Turbine Oil 2197)

(c) Mobil Jet Oil II

(d) Mobil Jet Oil 254

(e) Mobil Jet Oil 291

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

STORAGE AND PRESERVATION

Storage and preservation procedures must be applied for engines being not operated for a period of time according to the AMM. The preservation procedures protect the engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during period of inactivity.

CAUTION: under no circumstances shall preservative oil or equivalent be sprayed into the engine inlet, core compressor or turbine, or engine exhaust. Dirt particles on wet blades and vanes may adversely affect engine performance during subsequent operation.

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STORAGE AND PRESERVATION PROCEDURES MUST BE APPLIED FOR ENGINES BEING NOT OPERATED FOR A PERIOD OF TIME

PROTECTION AGAINST ATMOSPHERIC CONDITIONS

THE PRESERVATION PROCEDURES PROTECT THE ENGINE AGAINST CORROSION, LIQUID AND DEBRIS ENTERING THE ENGINE, AND ATMOSPHERIC CONDITIONS DURING PERIOD OF INACTIVITY

CAUTION

UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES ON WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.

STORAGE AND PRESERVATION

70 POWER PLANT RR TRENT 700 PRESENTATION (1)

ENVIRONMENTAL PRECAUTIONS

Do not discharge products such as oil, fuel, solvent, lubricant either in trash bins, soil or into the water network (drains, gutters, rain water, waste water, etc...).
Sort waste fluids and use specific waste disposal containers.
Each product must be stored in an appropriate and specific cabinet or room such as a fire-resistant and sealed cupboard.

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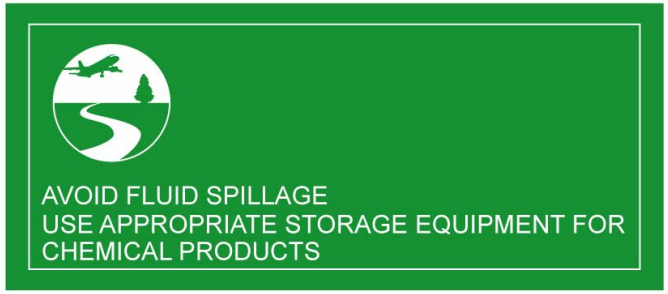
STORE PRODUCTS IN APPROPRIATE CONTAINER/CUPBOARD/ROOM

SORT WASTE FLUIDS IN CONTAINERS



FLUID SPILL CLEANUP KIT

USE SPECIFIC WASTE DISPOSAL CONTAINERS

ENVIRONMENTAL PRECAUTIONS

POWER PLANT INSTALLATION D/O (3)

BOOTSTRAP SYSTEM INSTALLATION

The removal and installation of the engine requires the installation of a bootstrap system on the aircraft pylon. The bootstrap system is composed of two elements, to be installed at the front and at the rear of the pylon. Each element is used to attach at its ends the chain pulley blocks assembly and dynamometers that are used to lower or to lift the transportation stand attached to the engine.

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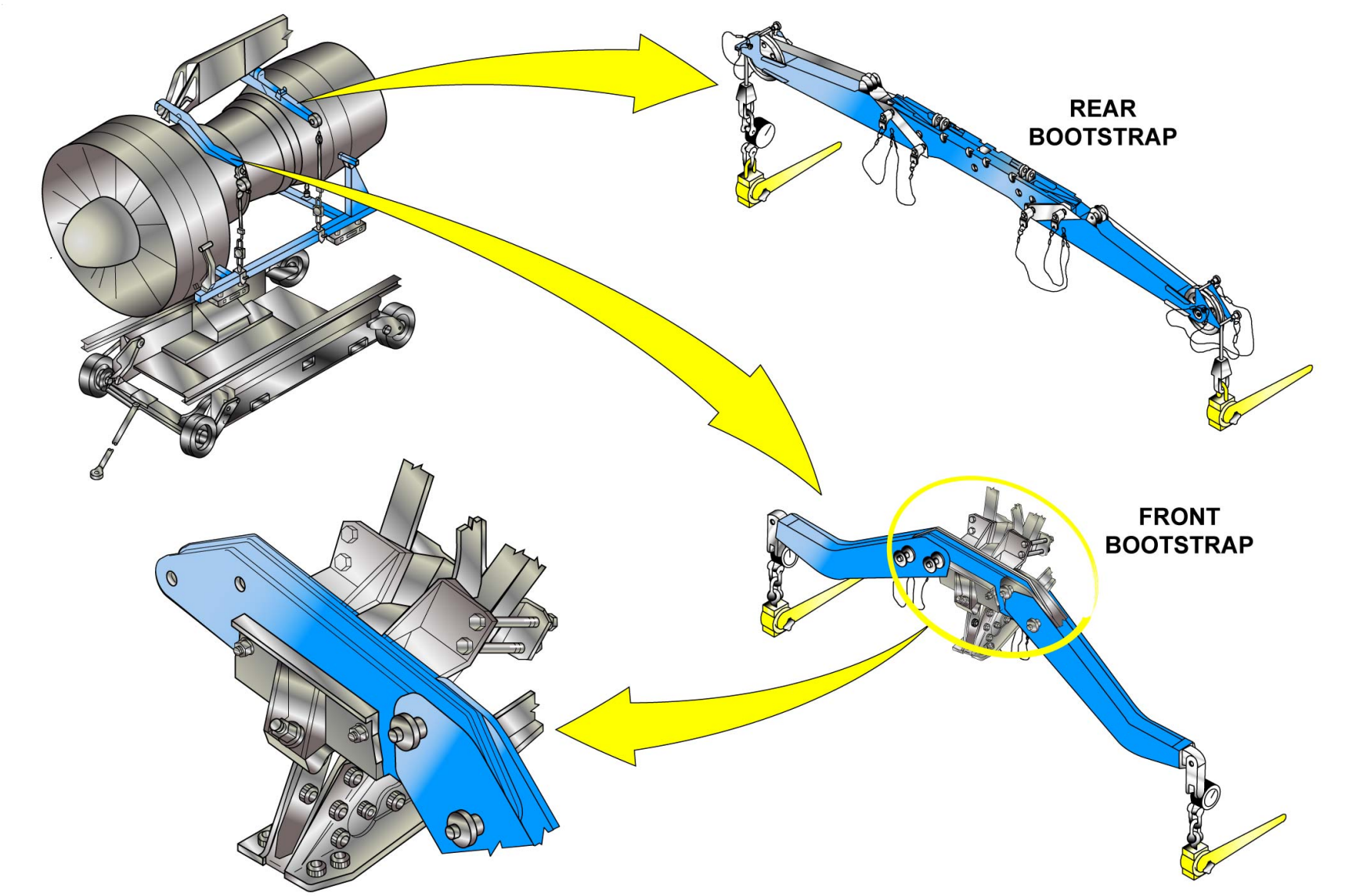

BOOTSTRAP SYSTEM INSTALLATION

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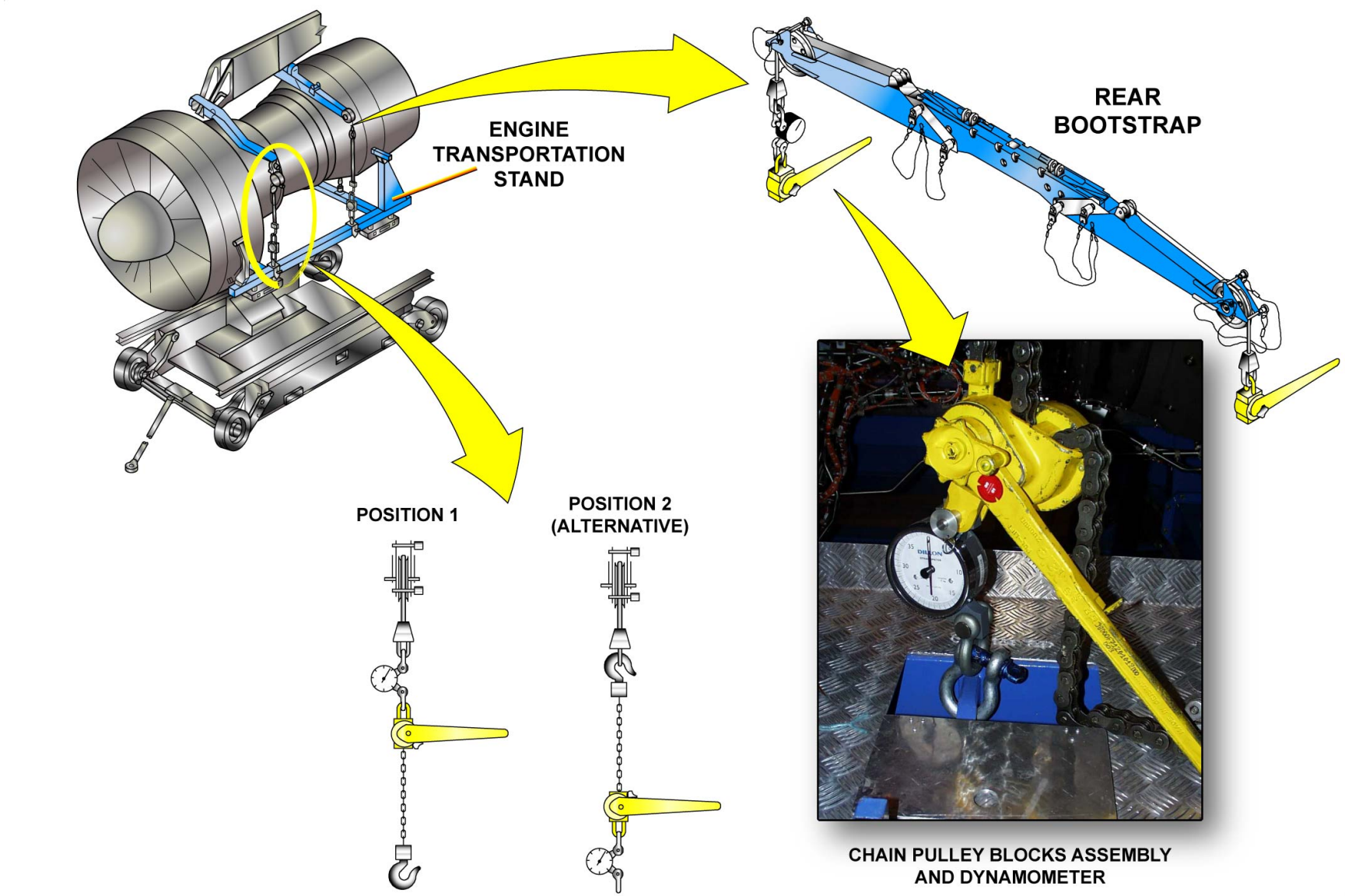
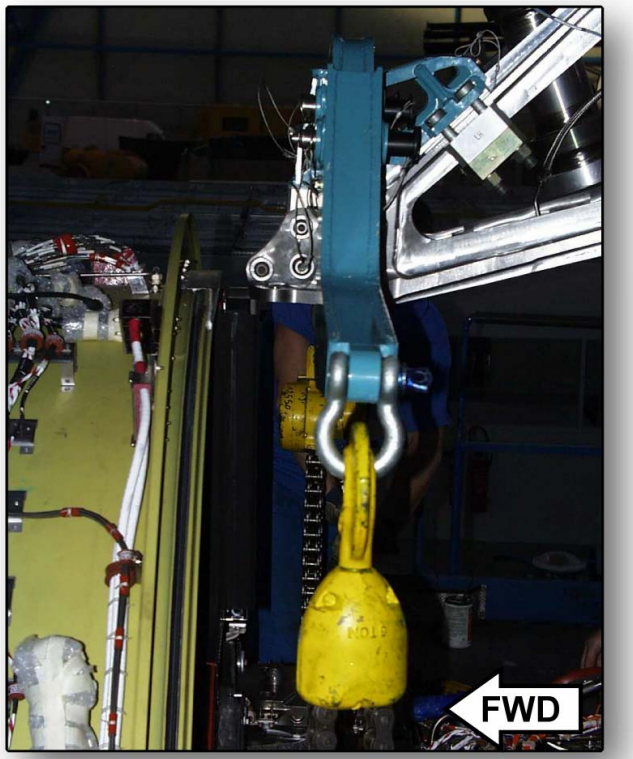
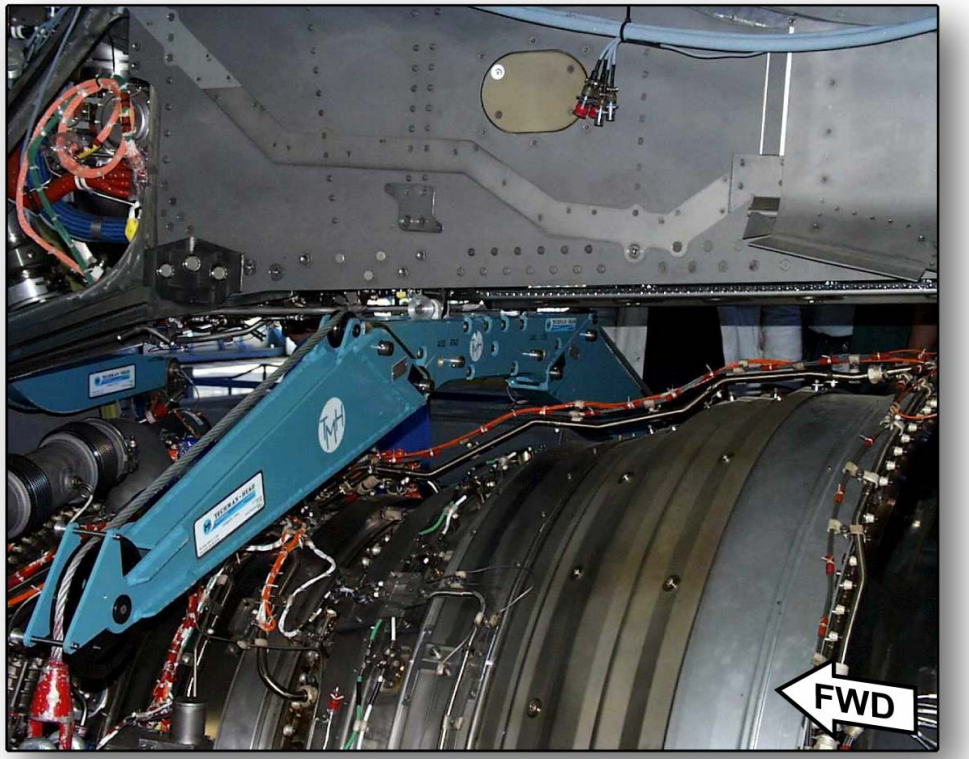


BOOTSTRAP SYSTEM INSTALLATION



FRONT BOOTSTRAP



REAR BOOTSTRAP

BOOTSTRAP SYSTEM INSTALLATION

POWER PLANT INSTALLATION D/O (3)

ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

The engine transportation stand, which is used for engine removal and installation, can be attached to the engine by four trunnions:
- two front trunnions attached onto the intermediate case, on the LH side and RH sides,
- two rear trunnions attached onto the tail bearing housing, on the LH side and RH sides.

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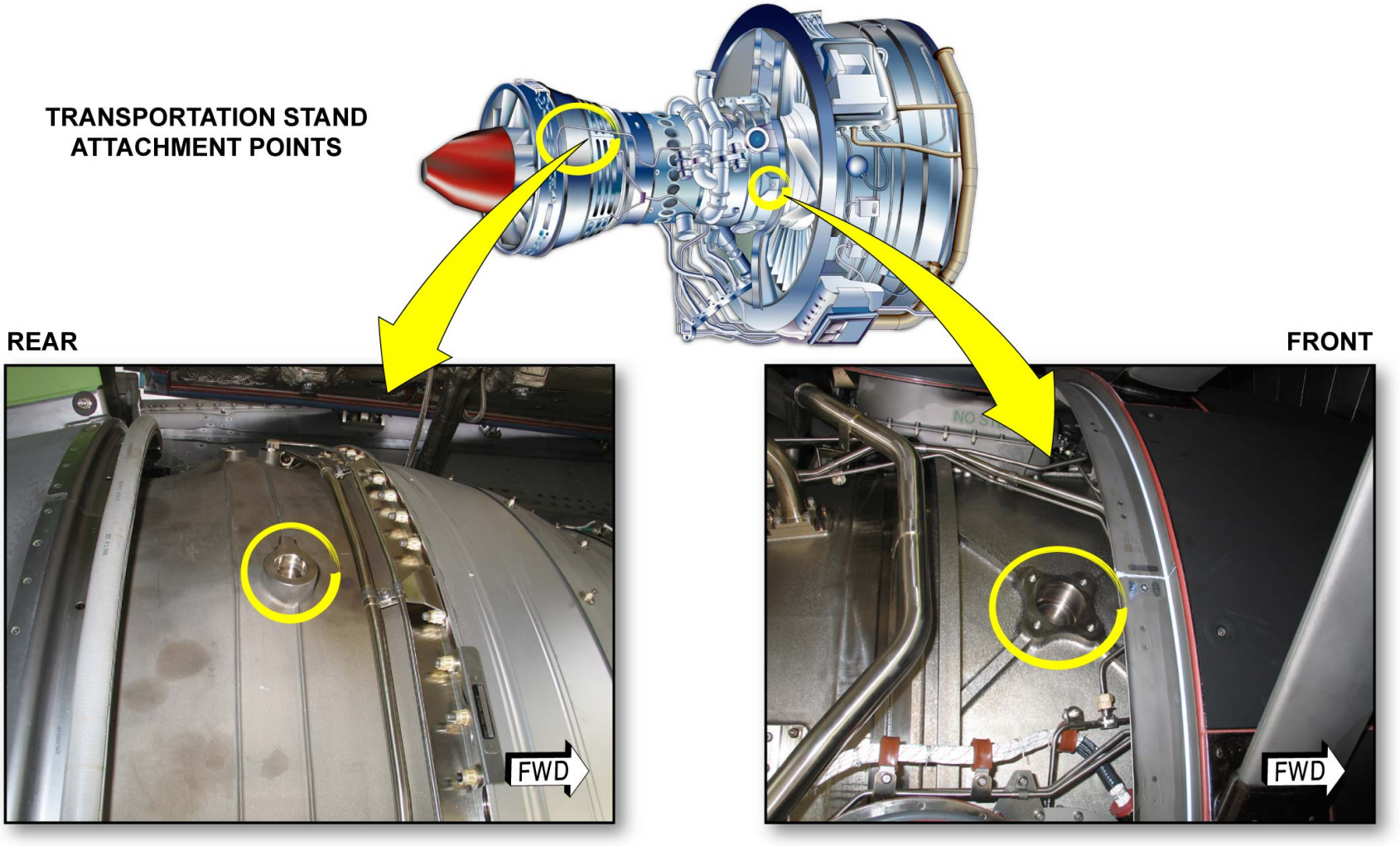

ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

POWER PLANT INSTALLATION D/O (3)

ENGINE MOUNTS

The engine is attached to the aircraft pylon by two mounts, which support the weight of the engine and transmit thrust loads to the aircraft structure.
The engine front mount is installed on the top of the engine intermediate case and is attached to the aircraft pylon by four tension bolts. The front mount is designed with a failsafe feature and transmits vertical, side and thrust loads to the aircraft pylon.
The engine rear mount is installed on top of the turbine exhaust case and is attached to the aircraft pylon by four tension bolts. This mount is also designed with a failsafe feature, and transmits vertical, side and torsion loads to the aircraft pylon.

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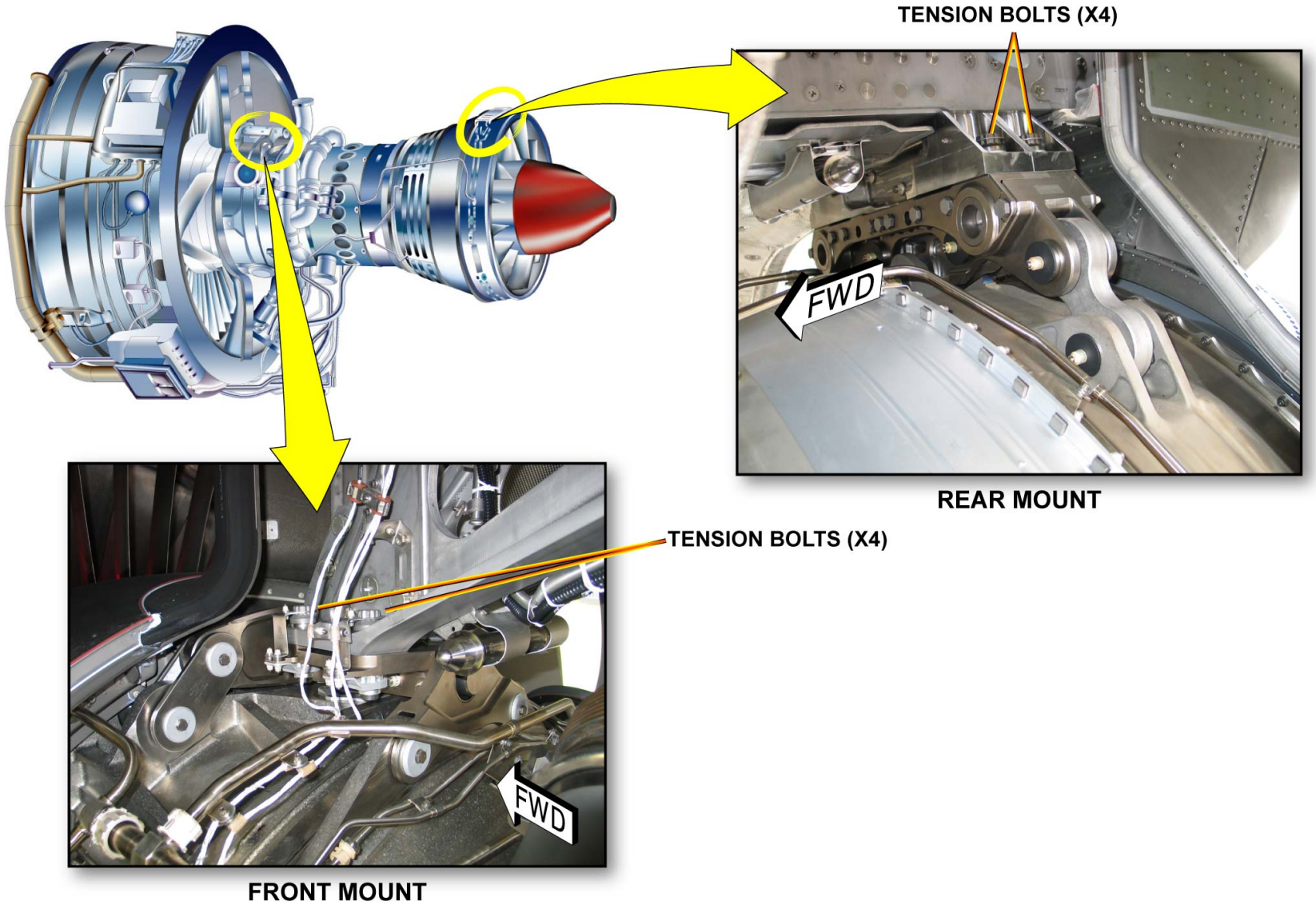

ENGINE MOUNTS

POWER PLANT INSTALLATION D/O (3)

FLUID CONNECTIONS

The fluid connections between engine and aircraft pylon are located on the RH side of the fan case. The fluid connection line for the fuel system is the LP fuel supply line. The fluid connection lines for the hydraulic system are:

- the hydraulic pressure line and suction line of the green system,
- the hydraulic pressure line and suction line of the blue or yellow system,
- the hydraulic case drain of the green system,
- the hydraulic case drain of the blue or yellow system .

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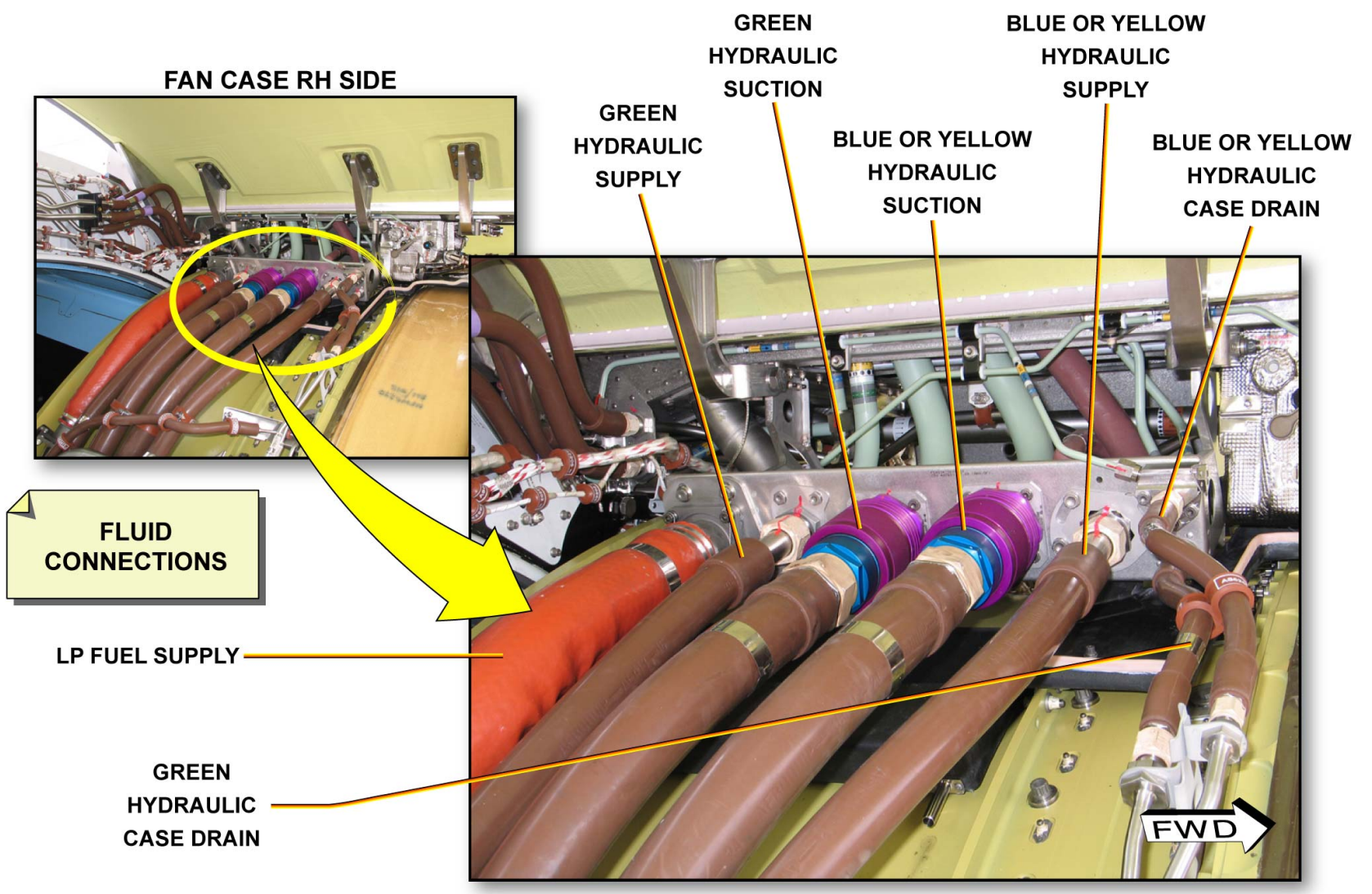

FLUID CONNECTIONS

POWER PLANT INSTALLATION D/O (3)

THRUST REVERSER ISOLATION CONTROL UNIT (ICU) ELECTRICAL CONNECTION

The Isolation Control Unit (ICU) of the Thrust Reverser system receives two electrical connectors for its control and monitoring.

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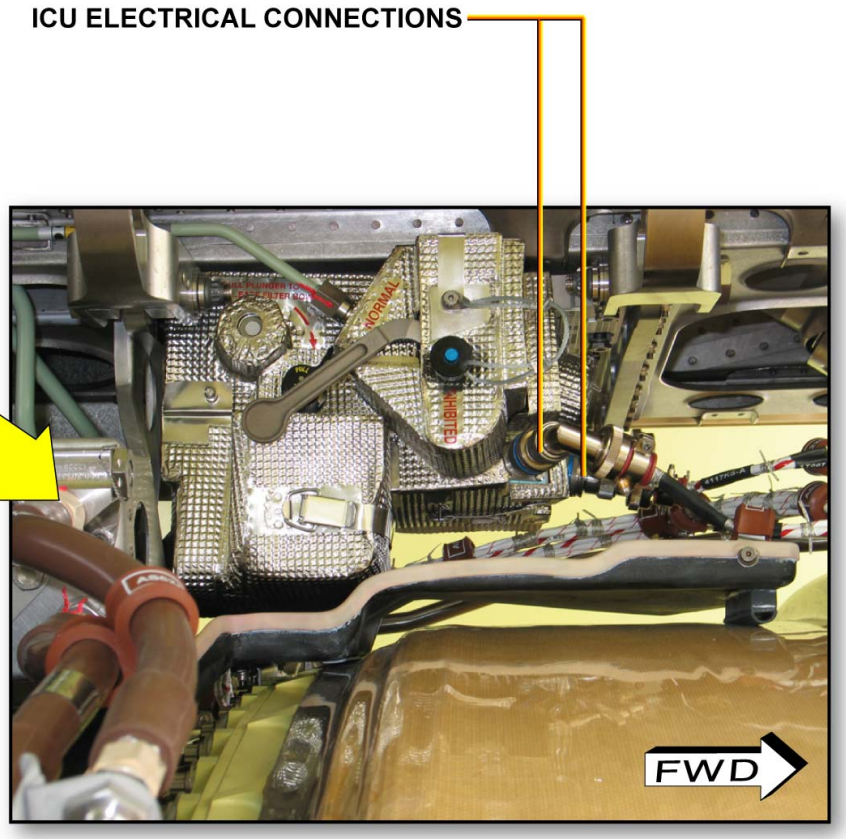
FAN CASE RH SIDE



ISOLATION CONTROL UNIT (ICU)

THRUST REVERSER ISOLATION CONTROL UNIT (ICU) ELECTRICAL CONNECTION

POWER PLANT INSTALLATION D/O (3)

FAN ELECTRICAL INTERFACE PANEL

The fan electrical interface panel is used for the connections between the fan electrical harnesses and the pylon. It is installed on the LH side of the fan case upper part.

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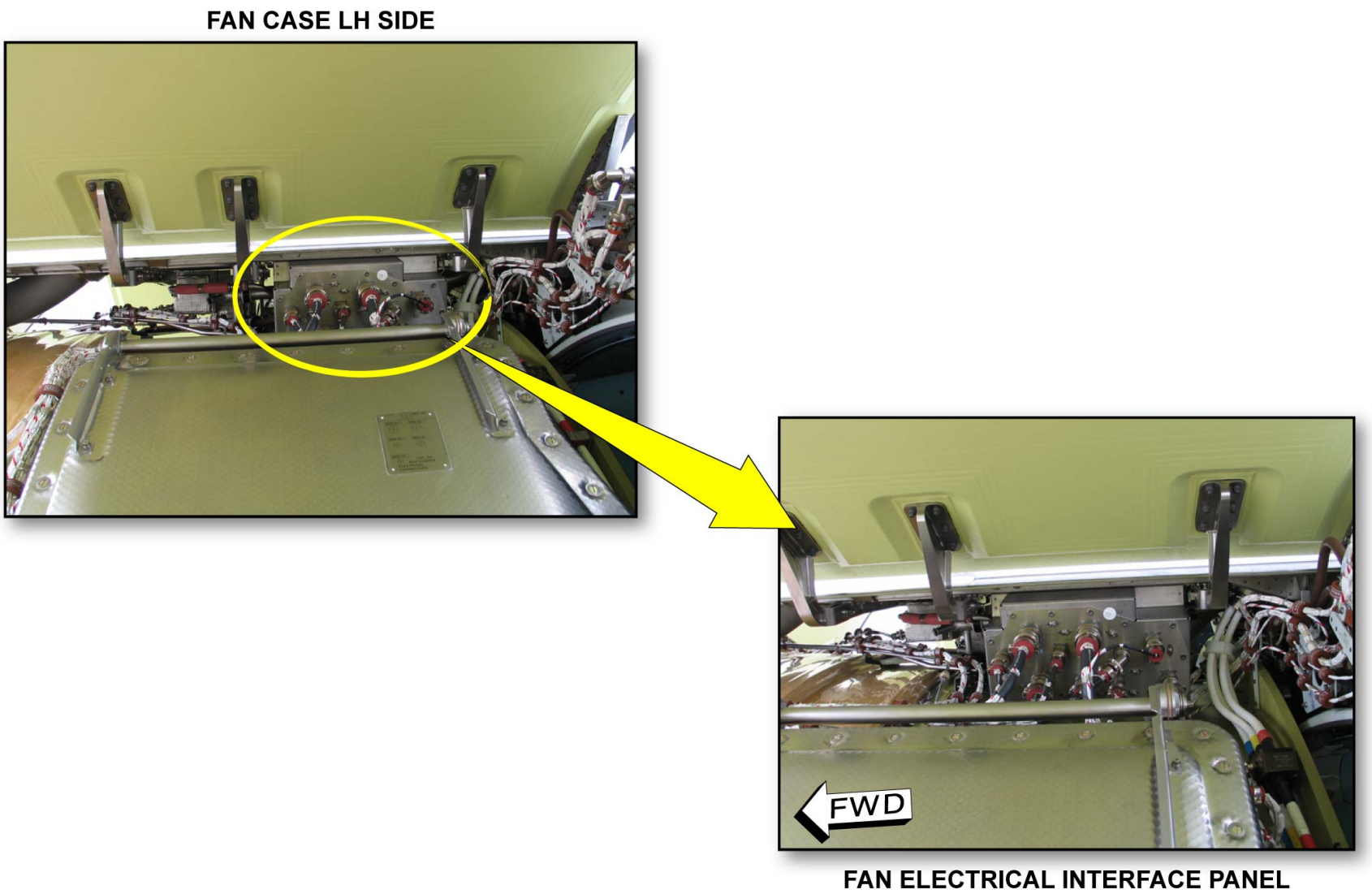

FAN ELECTRICAL INTERFACE PANEL

POWER PLANT INSTALLATION D/O (3)

CORE ELECTRICAL INTERFACE PANEL

The core electrical interface panel is used for the connections between the core electrical harnesses and the pylon. It is installed near to the engine front mount.

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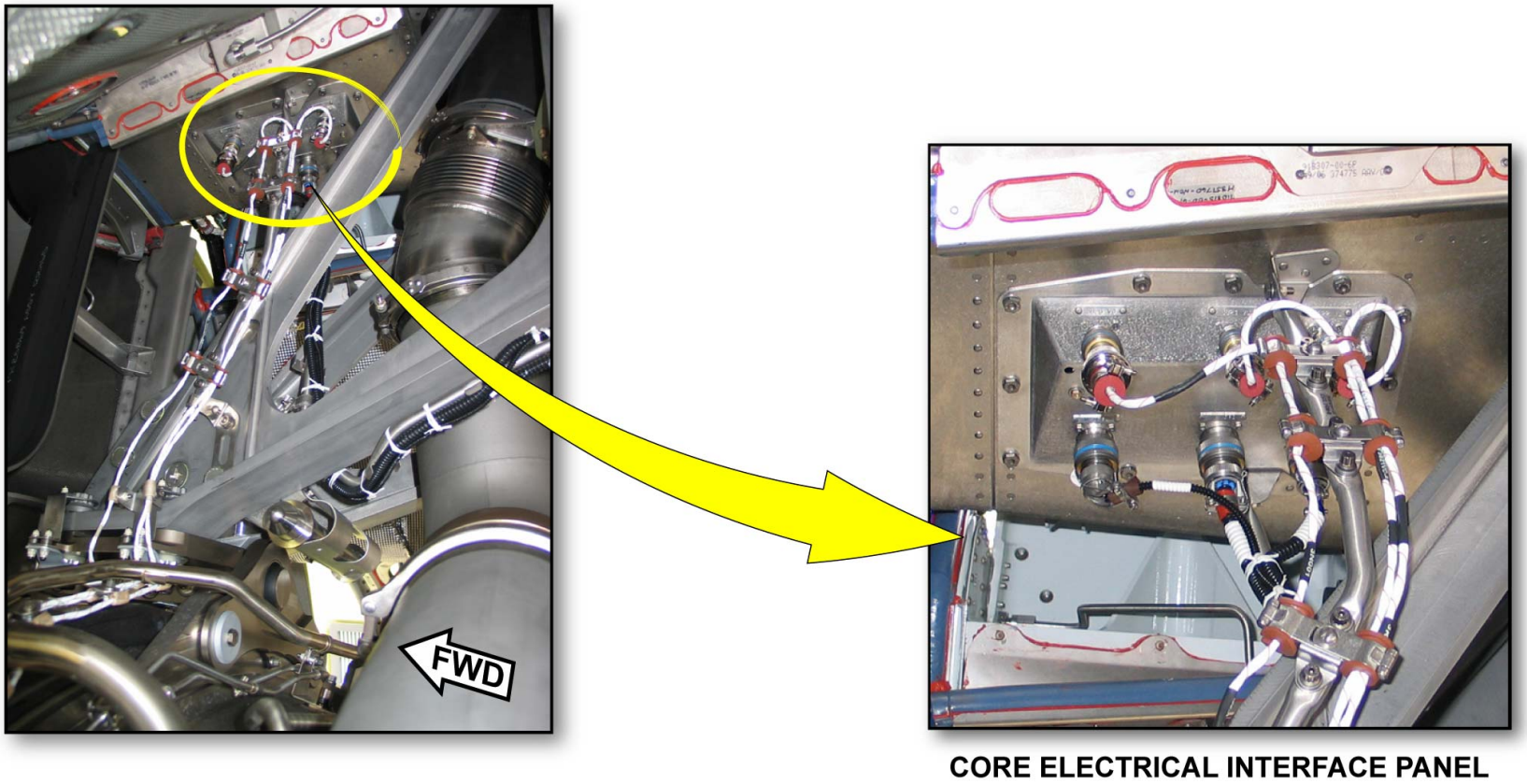

CORE ELECTRICAL INTERFACE PANEL

POWER PLANT INSTALLATION D/O (3)

IDG POWER CABLES TERMINAL BLOCK

The IDG power cables are routed vertically at the rear of the LH fan case. They are connected to the aircraft cables through a terminal block located near the fan electrical interface panel.

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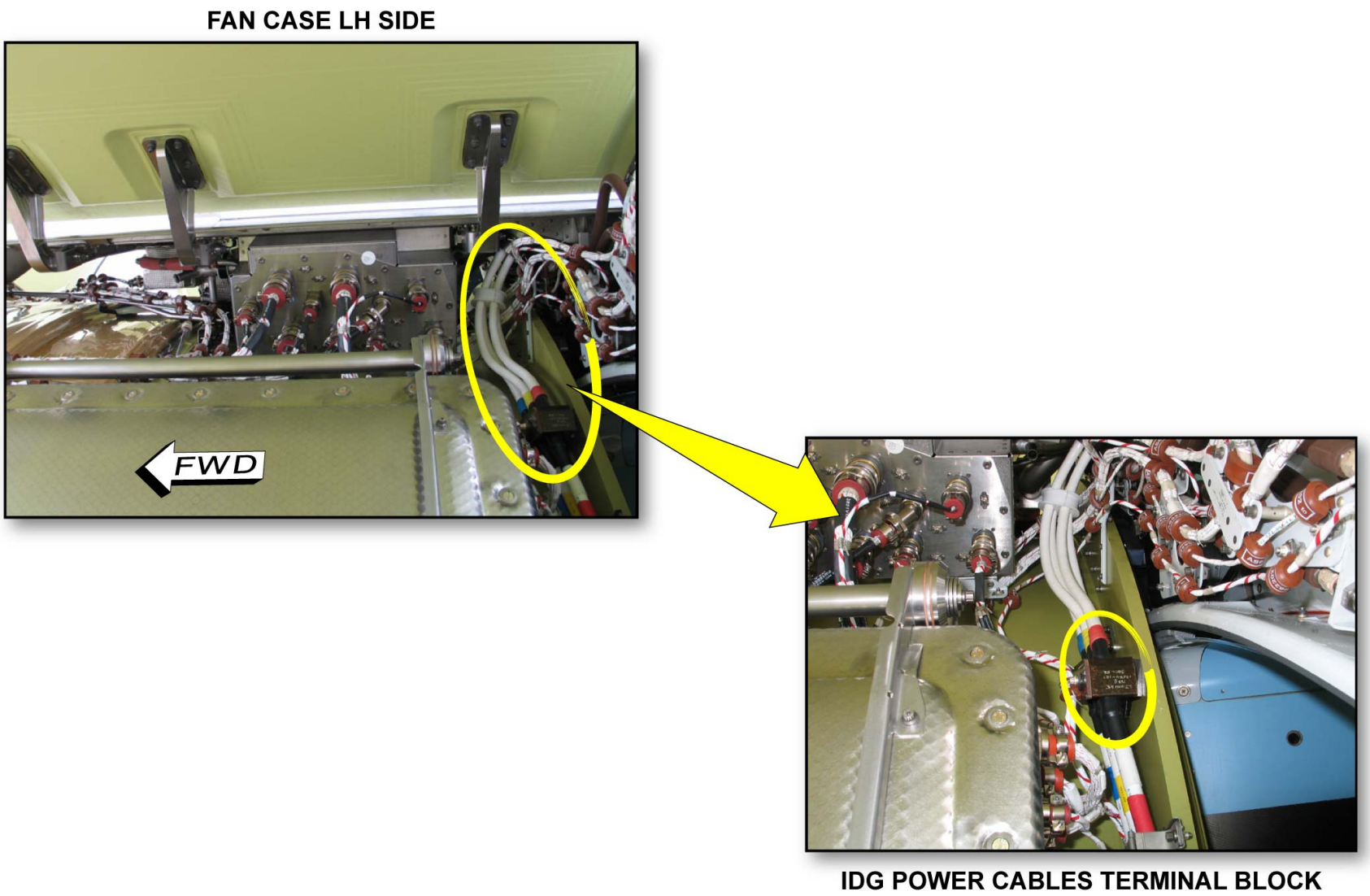

IDG POWER CABLES TERMINAL BLOCK

POWER PLANT INSTALLATION D/O (3)

EEC PROTECTION BOX ELECTRICAL CONNECTIONS

The Engine Electronic Controller (EEC) protection box receives electrical connectors at the top RH corner to get the electrical connections to the EEC, the Overspeed Protection Unit (OPU) and the Power Control Unit (PCU).

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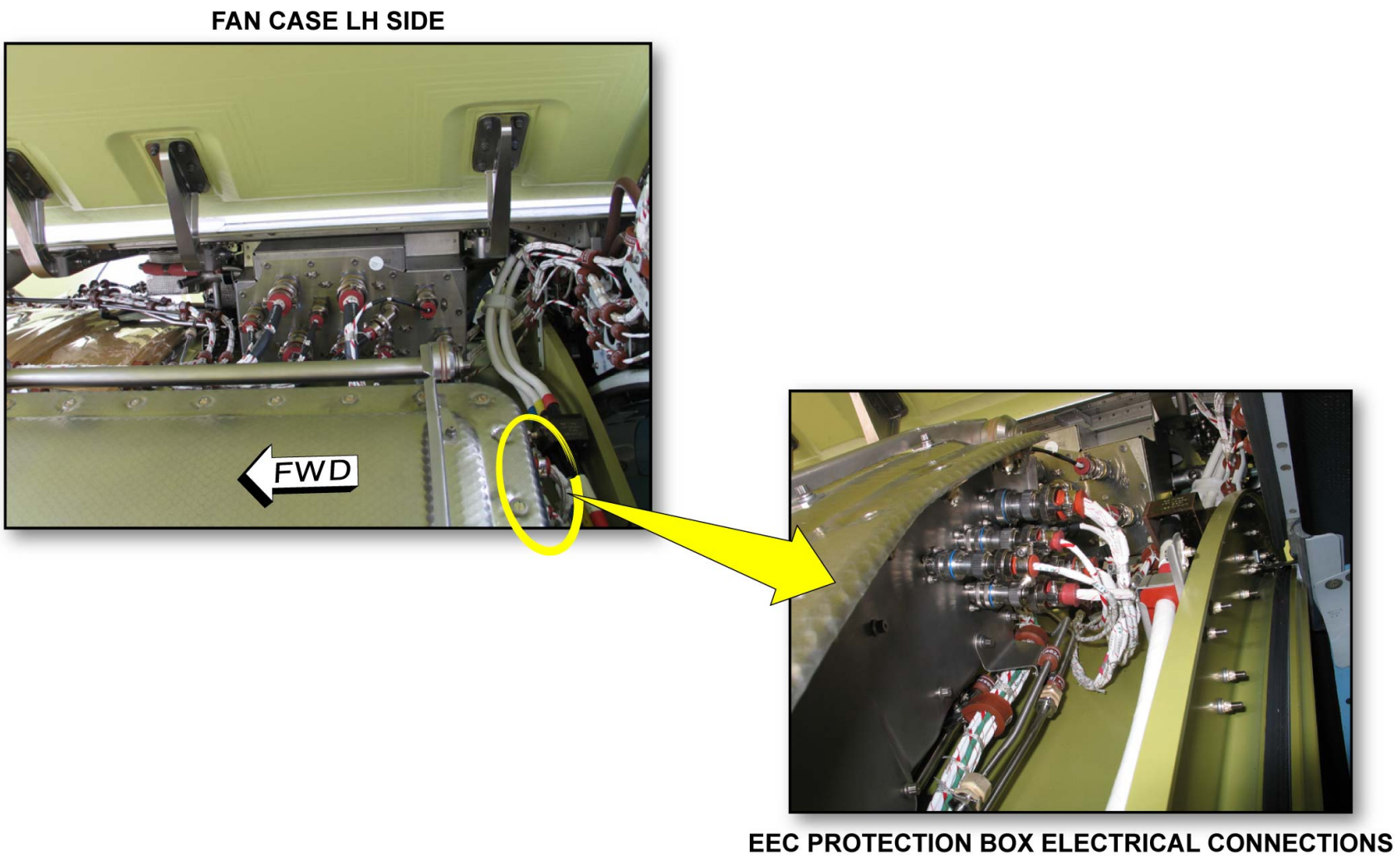


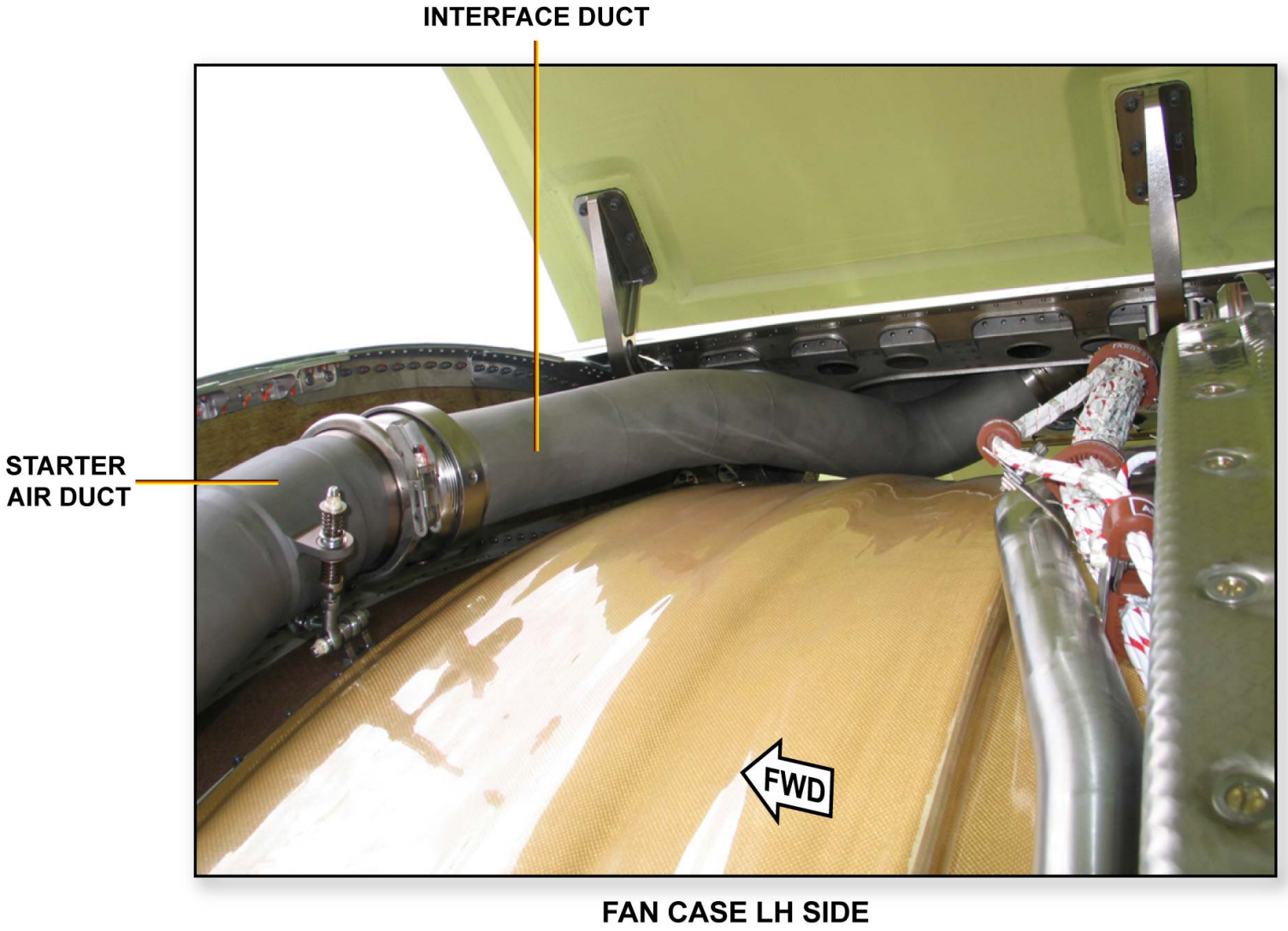
EEC PROTECTION BOX ELECTRICAL CONNECTIONS

POWER PLANT INSTALLATION D/O (3)

PNEUMATIC DUCTS CONNECTION

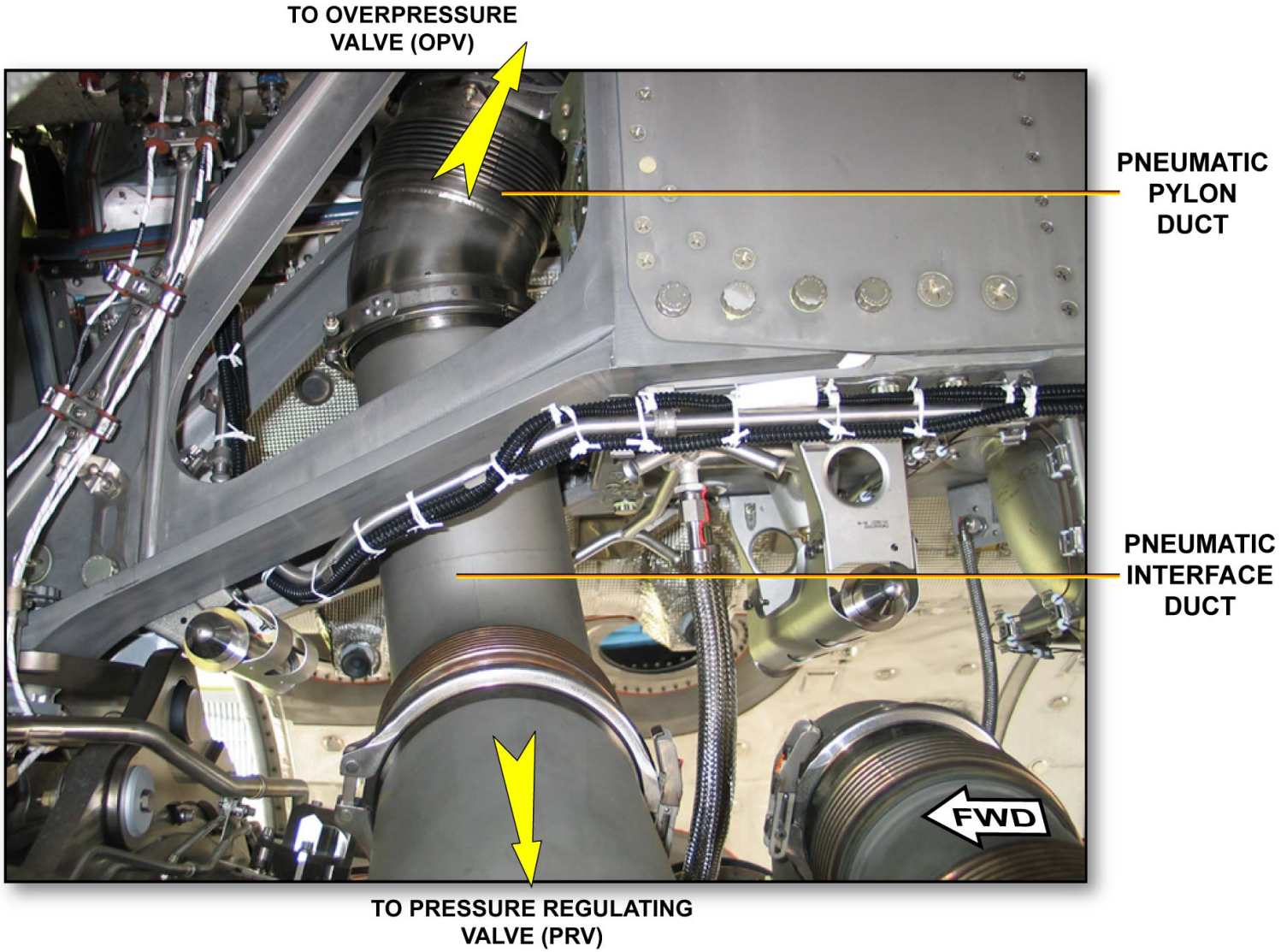
The starter air duct is installed at the front of the LH fan case. It is connected to the pylon through an interface duct attached by two clamps. The connection of the engine bleed air system to the aircraft pneumatic system is done on the LH side of engine core through an interface duct attached by 2 clamps.

GCL13151 - G6RT1DU - FM70D900000071



FAN CASE LH SIDE

PNEUMATIC DUCTS CONNECTION



PNEUMATIC DUCTS CONNECTION

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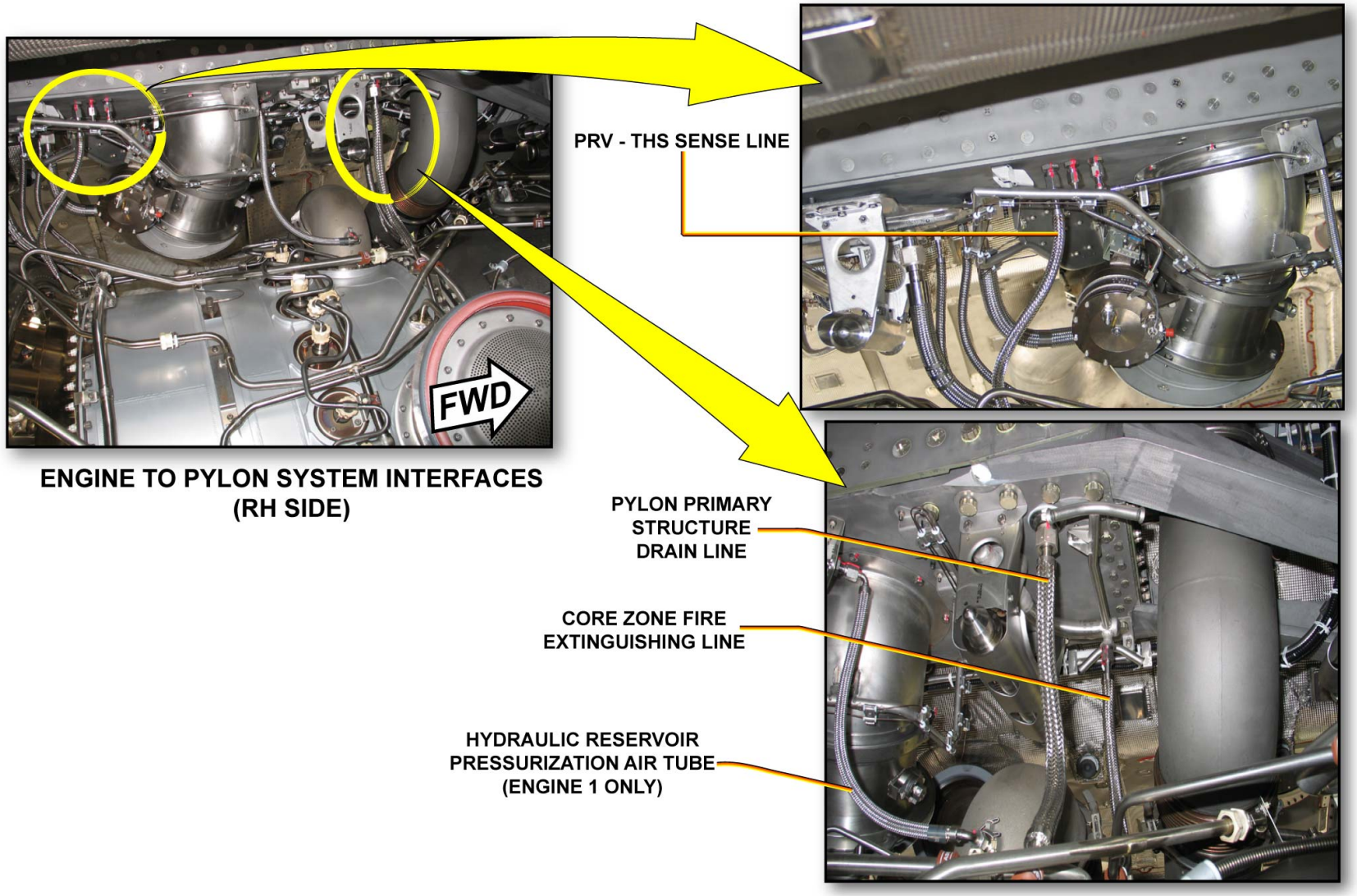
POWER PLANT INSTALLATION D/O (3)

SYSTEM PYLON INTERFACES

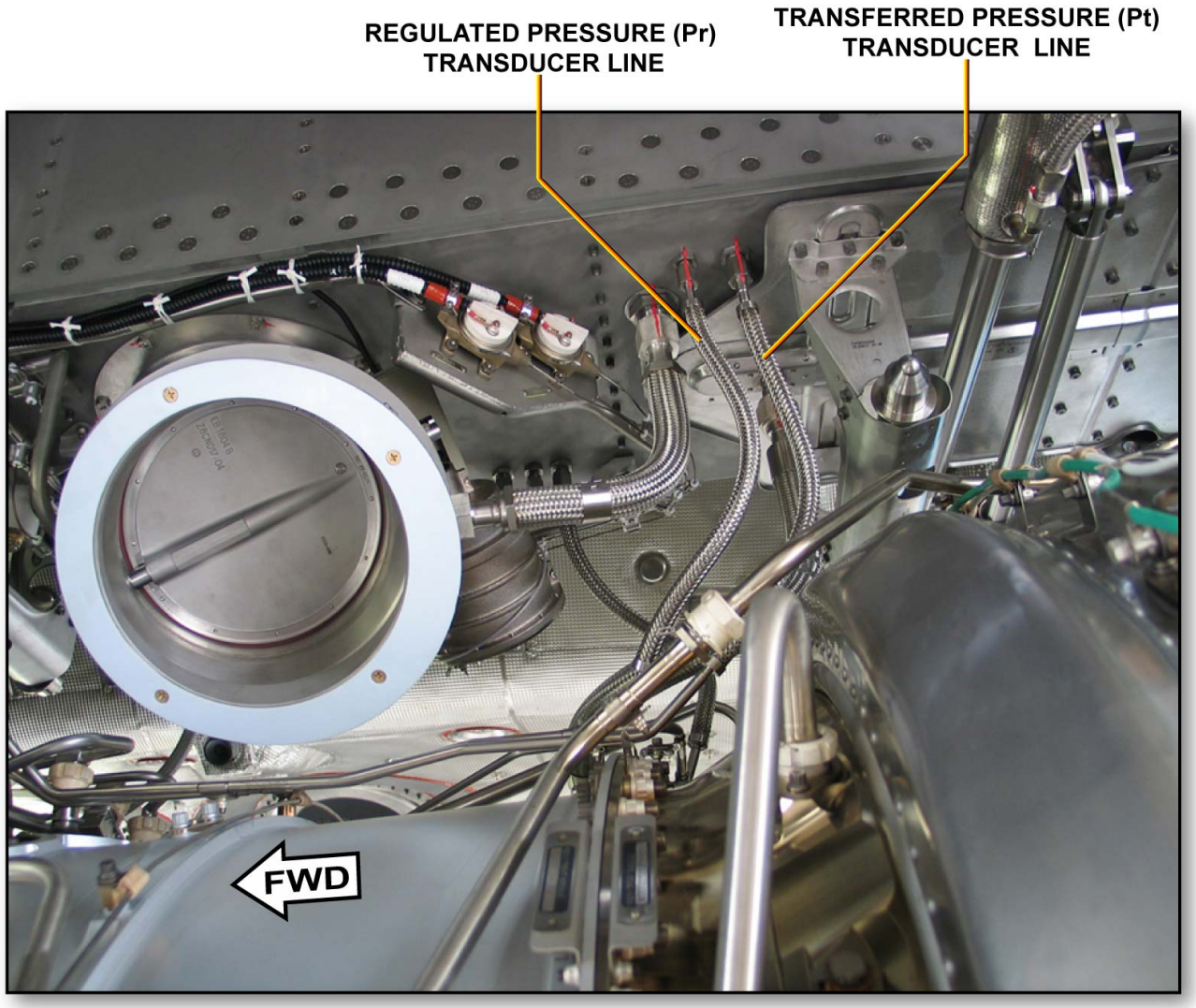
The following system connections are connected with the engine to the pylon interface, on the RH side:
- core zone fire extinguishing line,
- hydraulic reservoir pressurization air tube (engine 1 only),
- sense line connecting Pressure Regulating Valve (PRV) to Thermostat Solenoid (THS) of engine bleed air system.

The sense lines connecting to the bleed Regulated Pressure (Pr) transducer and the Transferred Pressure (Pt) transducer interface with the pylon on the LH side.

GCL13151 - G6RT1DU - FM70D900000071



SYSTEM PYLON INTERFACES



ENGINE TO PYLON SYSTEM INTERFACES (LH SIDE)

SYSTEM PYLON INTERFACES

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NACELLE D/O (3)

INLET COWL

The inlet cowl is attached to the forward flange of the LP compressor case (fan case) and is de-iced.
The air inlet cowl assembly is composed of:
- an inner and outer barrel,
- a rear bulkhead and,
- an intake cowl leading edge (lip) assembly which contains the forward bulkhead.

The assembly also has:
- a thermal anti ice air outlet,
- a P20/T20 probe and access panel,
- a zone 1 cooling air inlet,
- a maintenance interphone jack,
- electronic unit protection box cooling ducts,
- and four hoisting points.

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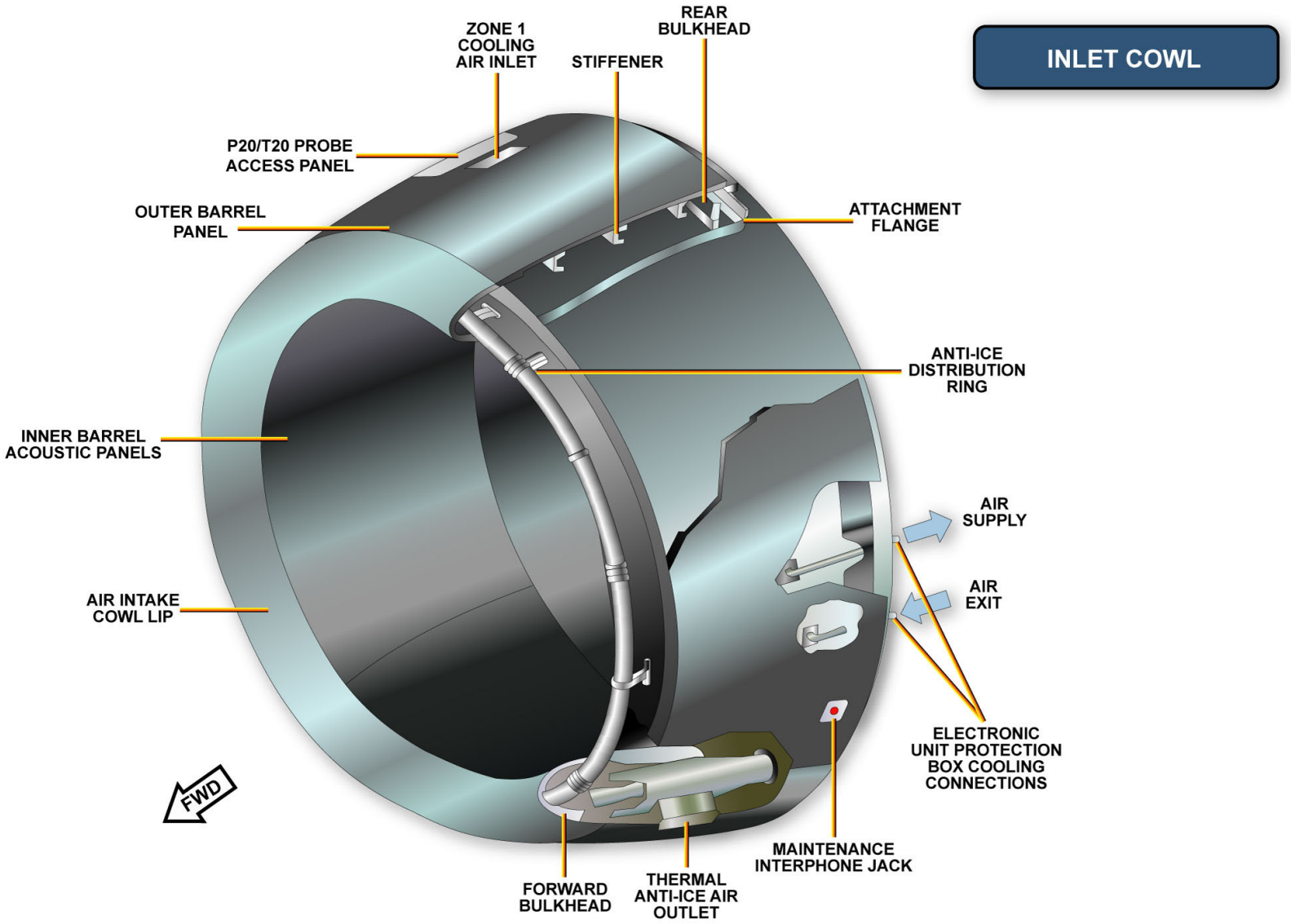
INLET COWL
ZONE 1 COOLING AIR INLET
REAR BULKHEAD
STIFFENER
P20/T20 PROBE ACCESS PANEL
OUTER BARREL PANEL
ATTACHMENT FLANGE
ANTI-ICE DISTRIBUTION RING
INNER BARREL ACOUSTIC PANELS
AIR SUPPLY
AIR EXIT
AIR INTAKE COWL LIP
ELECTRONIC UNIT PROTECTION BOX COOLING CONNECTIONS
FWD
MAINTENANCE INTERPHONE JACK
FORWARD BULKHEAD
THERMAL ANTI-ICE AIR OUTLET

INLET COWL

NACELLE D/O (3)

FAN COWL DOORS

The fan cowls are attached by four hinges and secured together by four latches at the bottom to close around the LP compressor case. Two deflection restraints make sure that the front lower corners cannot droop below the nose cowl line. They can be opened during ground maintenance to give access to the components installed on the case and on the gearbox, and let the thrust reverser halves (C-Duct) be opened.
Each fan cowl door is maintained open by means of two telescopic hold open rods.
There are two hold open positions, 55 degrees and 44 degrees. The 55 degrees maximum open position gives the access to the pylon interfaces and upper accessories. The 44 degrees position gives access to other features.
Each fan cowl door has various access doors and outlets.

LEFT FAN COWL

The left fan cowl has:
- the starter control valve, thrust reverser ground safety switch and anti ice valve access door,
- the Integrated Drive Generator (IDG) oil fill-sight glass and reset lever access door,
- and the IDG oil cooler air outlet.

RIGHT FAN COWL

The right fan cowl has:
- the oil fill sight-glass access door,
- a hydraulic filter contamination indicator and master Magnetic Chip Detector (MCD) access door,
- the Air Oil Heat Exchanger (AOHE) air outlet,
- the zone 1 airflow outlet,
- and the breather outlet mast.

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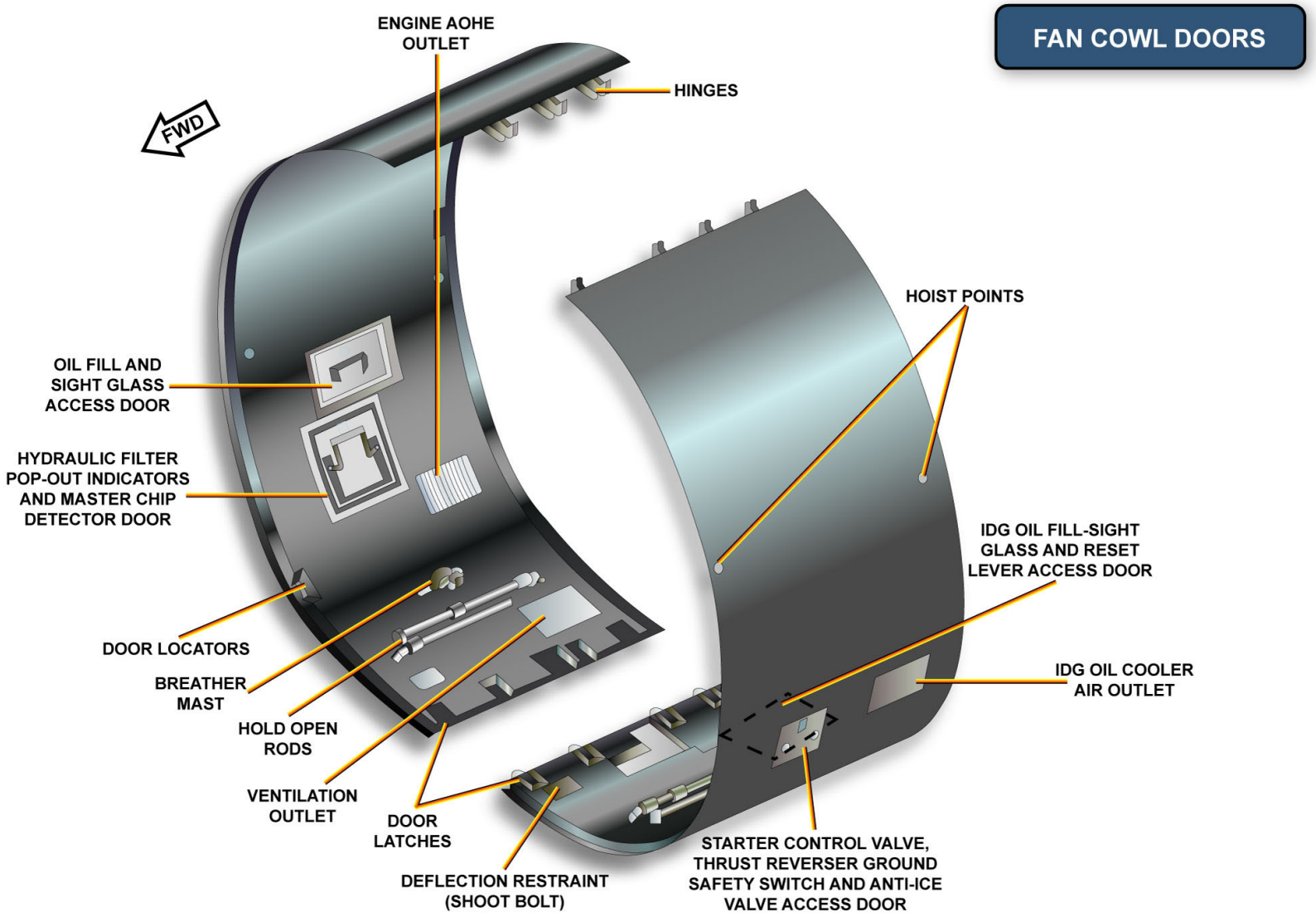
FAN COWL DOORS
ENGINE AOHE OUTLET
HINGES
FWD
HOIST POINTS
OIL FILL AND SIGHT GLASS ACCESS DOOR
HYDRAULIC FILTER POP-OUT INDICATORS AND MASTER CHIP DETECTOR DOOR
IDG OIL FILL-SIGHT GLASS AND RESET LEVER ACCESS DOOR
DOOR LOCATORS
BREATHER MAST
IDG OIL COOLER AIR OUTLET
HOLD OPEN RODS
VENTILATION OUTLET
DOOR LATCHES
DEFLECTION RESTRAINT (SHOOT BOLT)
STARTER CONTROL VALVE, THRUST REVERSER GROUND SAFETY SWITCH AND ANTI-ICE VALVE ACCESS DOOR

FAN COWL DOORS - LEFT FAN COWL & RIGHT FAN COWL

NACELLE D/O (3)

FAN COWL DOORS (continued)

FAN COWL LATCHES

The fan cowls are latched together along the bottom centerline by four latches. The RH fan cowl has four hook type latches that adjust in four keepers on the LH fan cowl.
The keepers and the latches are installed into housings. Each keeper housing has one spigot and one bolt to be in contact with its related latch housing.
The latch handles are visible when they are not properly engaged. They are flushing when they are correctly engaged.

NOTE: Note: You must not open the fan cowls if wind speed is 60 MPH (96 KMH) or more.

The fan cowl latches must be operated in the following sequence 1, 3, 2, 4 (numbered from the front to the rear) for locking and unlocking.

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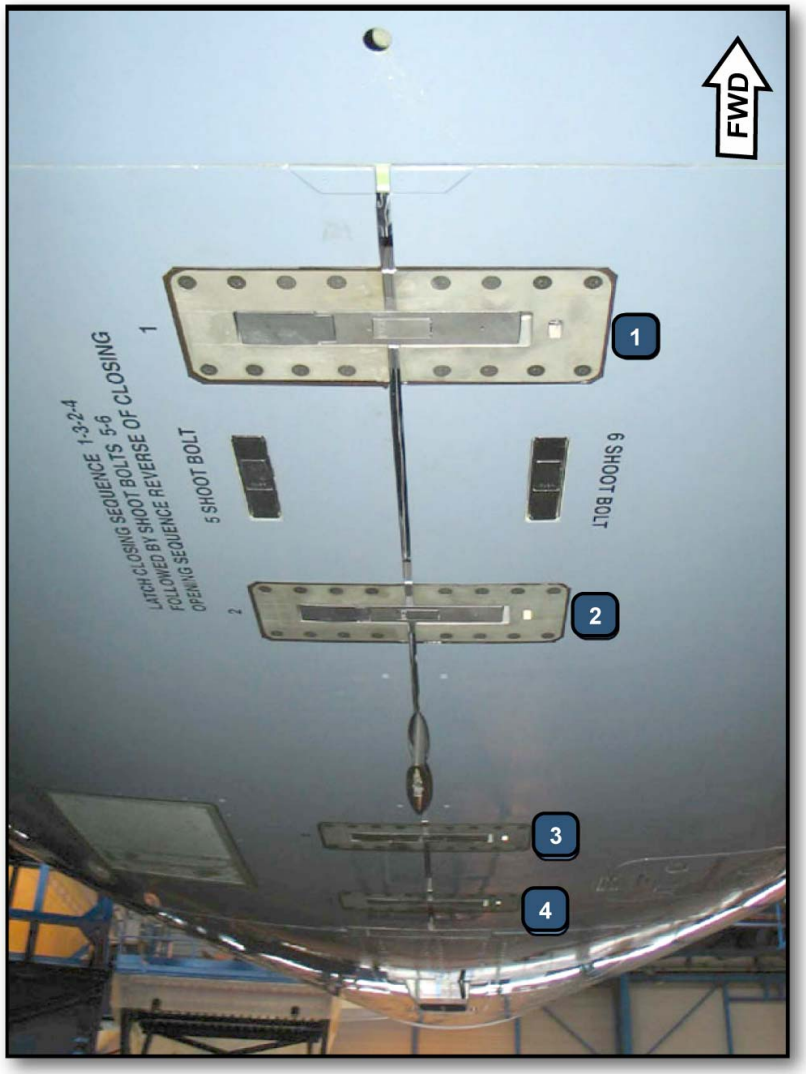

SEQUENCE FOR LOCKING AND UNLOCKING FAN COWL LATCHES

FAN COWL DOORS - FAN COWL LATCHES

NACELLE D/O (3)

THRUST REVERSER ASSEMBLY

The thrust reverser assembly has two halves (also called C-ducts) attached to the aircraft pylon with 5 hinges each and are latched together by means of 7 latches.
When the C-ducts are closed, they make a cover over the core engine and form a smooth bypass duct from the LP compressor (fan) into the Common Nozzle Assembly (CNA).
The thrust reverser assembly contains the mechanism for reversing the fan airflow during aircraft landing.
Each thrust reverser half opens hydraulically by means of an actuator located underneath the engine pylon and is secured open with two hold open rods. Operation of the actuators requires a hand operated hydraulic pump.
Each C-duct includes:
- a front frame,
- an inner fixed structure,
- an outer fixed structure,
- two pivoting doors.

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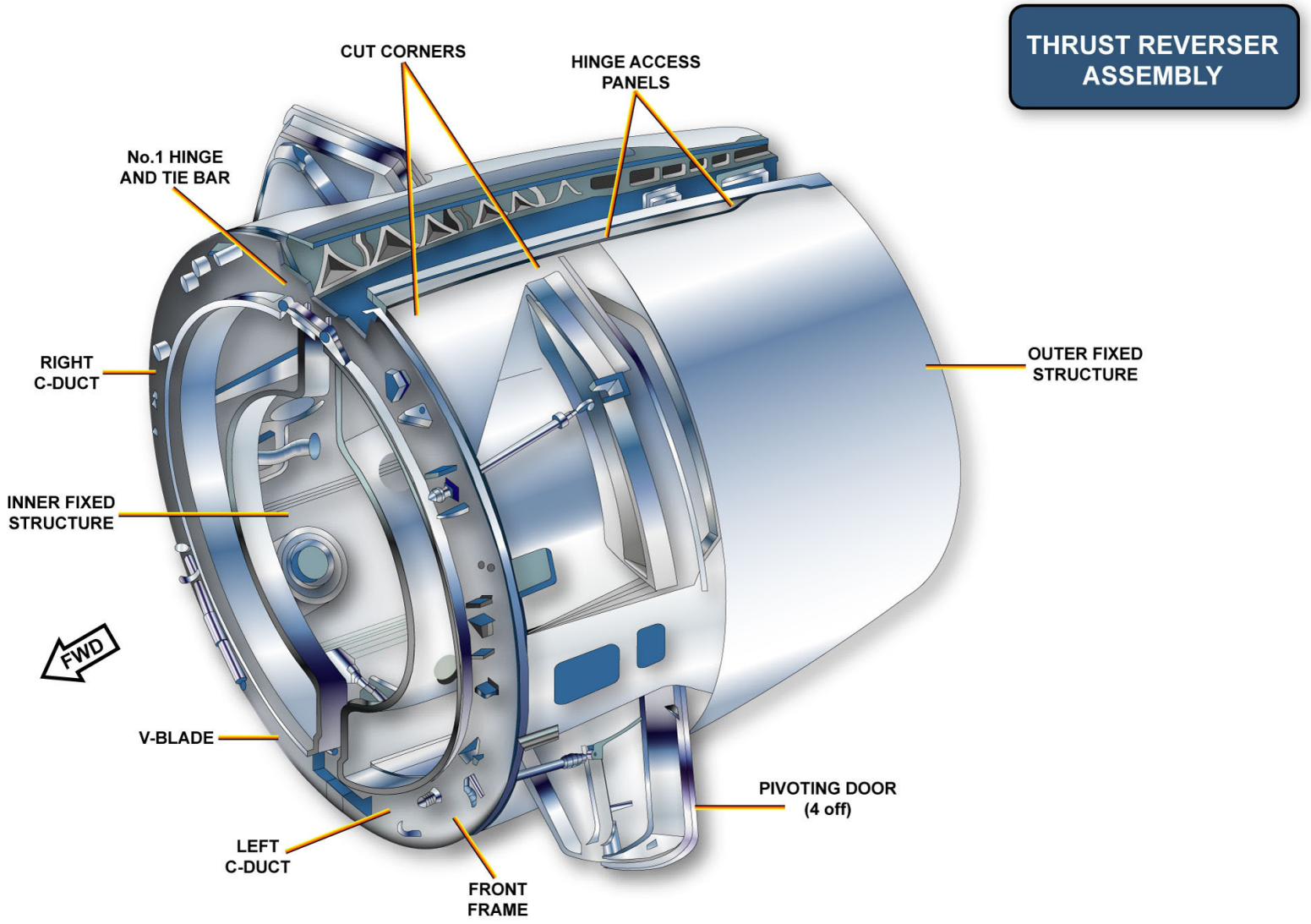

THRUST REVERSER ASSEMBLY

GCL13151 - G6RT1DU - FM70D800000071

NACELLE D/O (3)

THRUST REVERSER ASSEMBLY (continued)

THRUST REVERSER ASSEMBLY LATCHES

The C-ducts are latched together with seven latches:
- The number 1 latch is mounted on the front frame and is operated by a remote lever.
- The number 2 to 7 latches are mounted on the 6 o'clock beam.

Latches 3 and 4 are the shear-pin type and are accessible through the latch access and overpressure relief doors. The latches 1, 2, 5, 6 and 7 are of hook type.
A take-up device is installed between latches 3 and 4 that is used to pull the thrust reverser cowl doors together until you can fasten the latches easily.

NOTE: Note:
- You must not open the C-ducts if wind speed is 46 MPH (73 KMH) or more.
- Before opening the C-ducts the thrust reverser must be deactivated.
- The take-up device must be operated before to release the latches.
- The opening sequence is latches number 2, 5, 6, 7, 1, 3, 4.
- The closing sequence is latches number 3, 4, 1, 7, 6, 5, 2.

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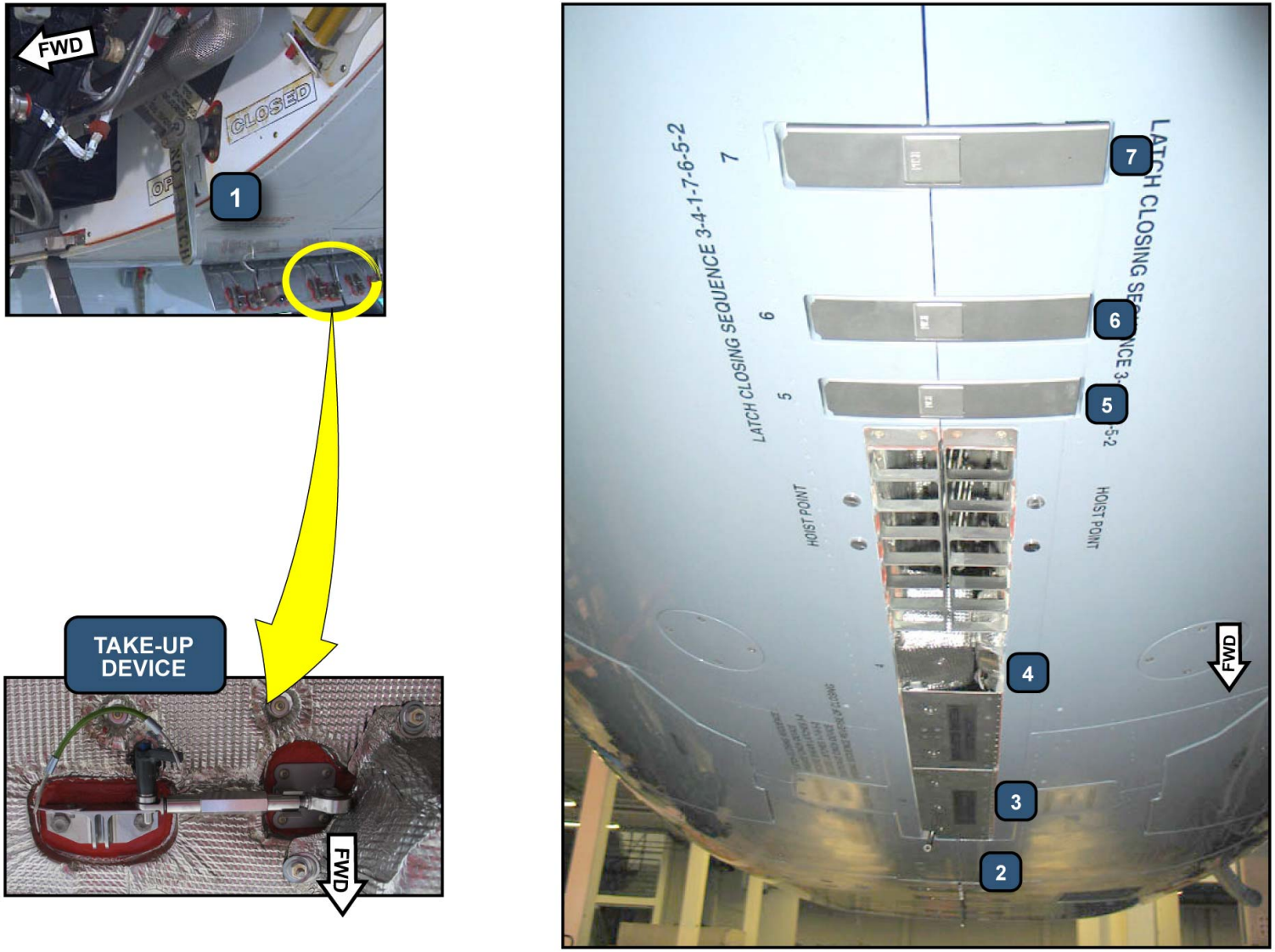


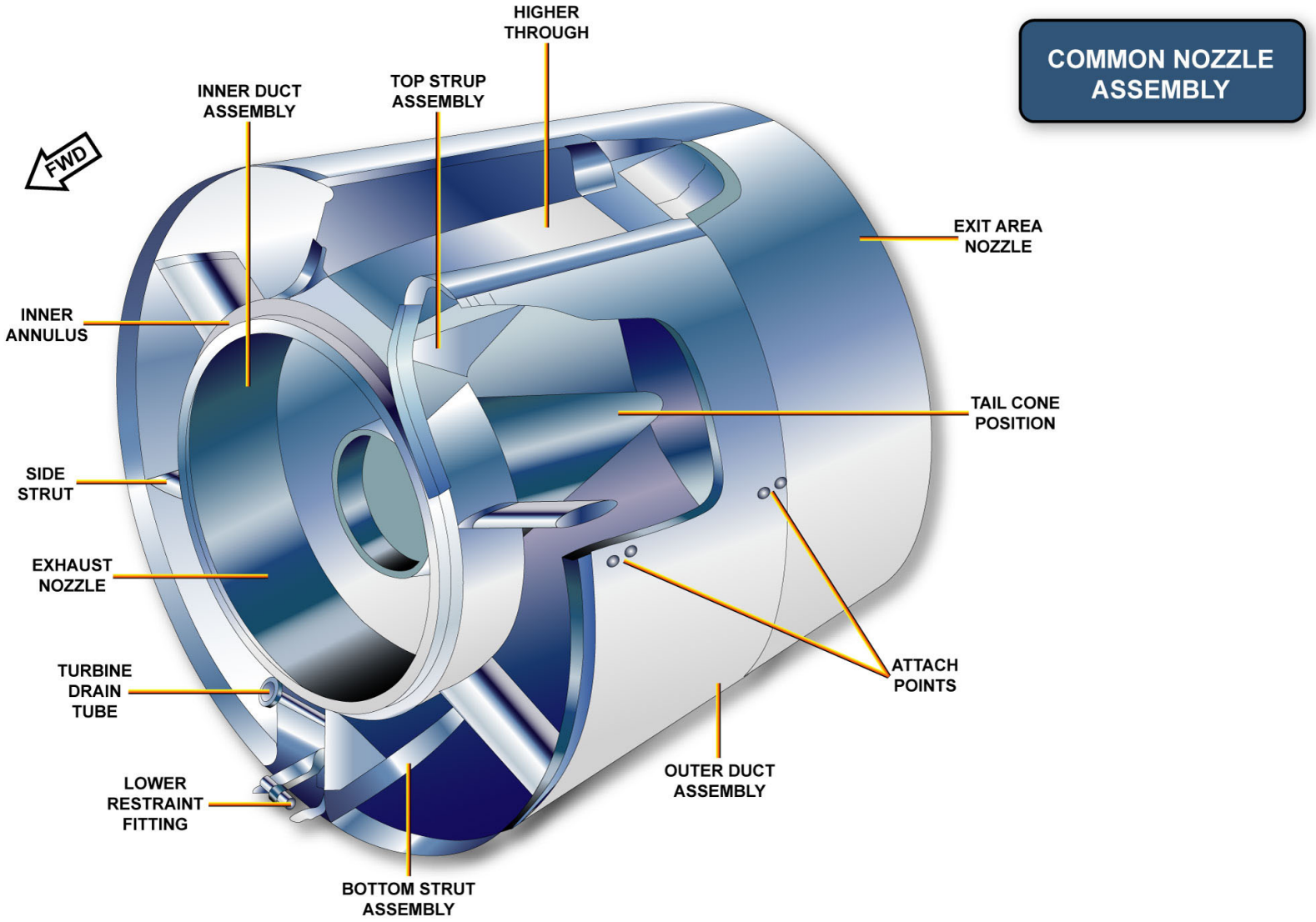
THRUST REVERSER ASSEMBLY - THRUST REVERSER ASSEMBLY LATCHES

NACELLE D/O (3)

COMMON NOZZLE ASSEMBLY

The function of the Common Nozzle Assembly (CNA) is to mix the core engine exhaust with the LP compressor (fan) air. The CNA has the shape of a convergent duct which increases the velocity of the mixed gas and thus gives added thrust.
The CNA is attached directly onto the LP turbine module of the engine. The CNA is an interchangeable assembly that has an inner and an outer duct assembly. The inner duct assembly is annular and is the primary exhaust nozzle around the core engine exhaust. The outer duct assembly is held by six aerodynamic struts attached to the inner duct assembly.
If the CNA is replaced by an other CNA, which doesn't have the same nozzle EPR number, you can enter the new number with the Data Entry Plug (DEP).

GCL13151 - G6RT1DU - FM70D800000071



COMMON NOZZLE ASSEMBLY

GCL13151 - G6RT1DU - FM70D800000071

COMMON NOZZLE ASSEMBLY

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GCL13151 - G6RT1DU - FM70D800000071

NACELLE D/O (3)

NACELLE ACCESS DOORS

Various access doors and panels around the engine give access to maintenance and servicing purposes.
These doors and panels are:
- P20/T20 probe access panel,
- hydraulic filter contamination indicator and master MCD access door,
- oil fill and sight glass access door,
- starter control valve and thrust reverser ground safety switch access door,
- IDG oil fill-sight glass and reset lever access door,
- pivot access panels,
- thrust reverser Rotational Variable Transducer (RVT) access panels,
- number 4 latch access panels.

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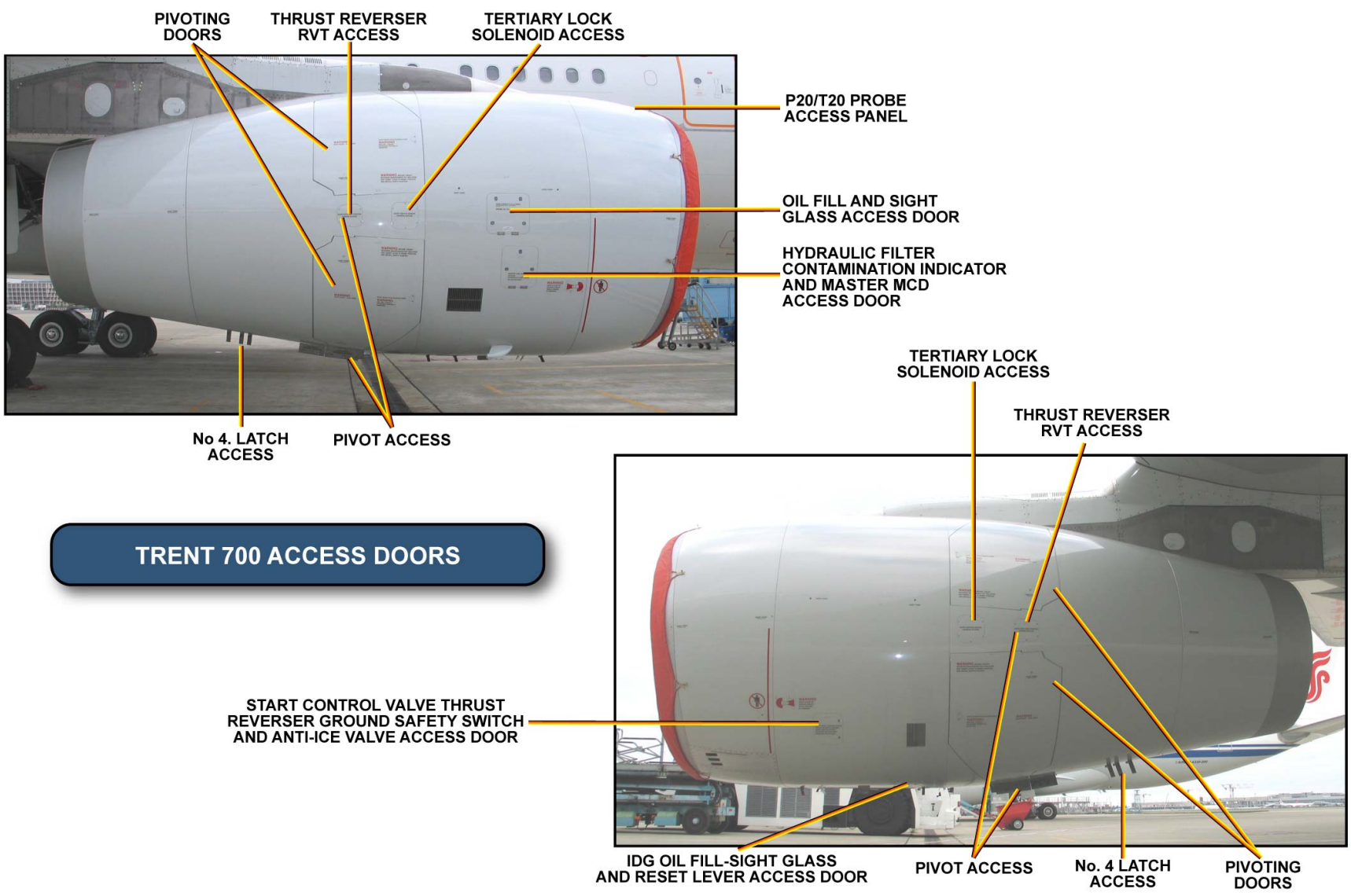

PIVOTING DOORS
THRUST REVERSER RVT ACCESS
TERTIARY LOCK SOLENOID ACCESS
P20/T20 PROBE ACCESS PANEL
OIL FILL AND SIGHT GLASS ACCESS DOOR
HYDRAULIC FILTER CONTAMINATION INDICATOR AND MASTER MCD ACCESS DOOR
No 4. LATCH ACCESS
PIVOT ACCESS
TRENT 700 ACCESS DOORS
TERTIARY LOCK SOLENOID ACCESS
THRUST REVERSER RVT ACCESS
START CONTROL VALVE THRUST REVERSER GROUND SAFETY SWITCH AND ANTI-ICE VALVE ACCESS DOOR
IDG OIL FILL-SIGHT GLASS AND RESET LEVER ACCESS DOOR
PIVOT ACCESS
No. 4 LATCH ACCESS
PIVOTING DOORS

NACELLE ACCESS DOORS

GCL13151 - G6RT1DU - FM70D800000071

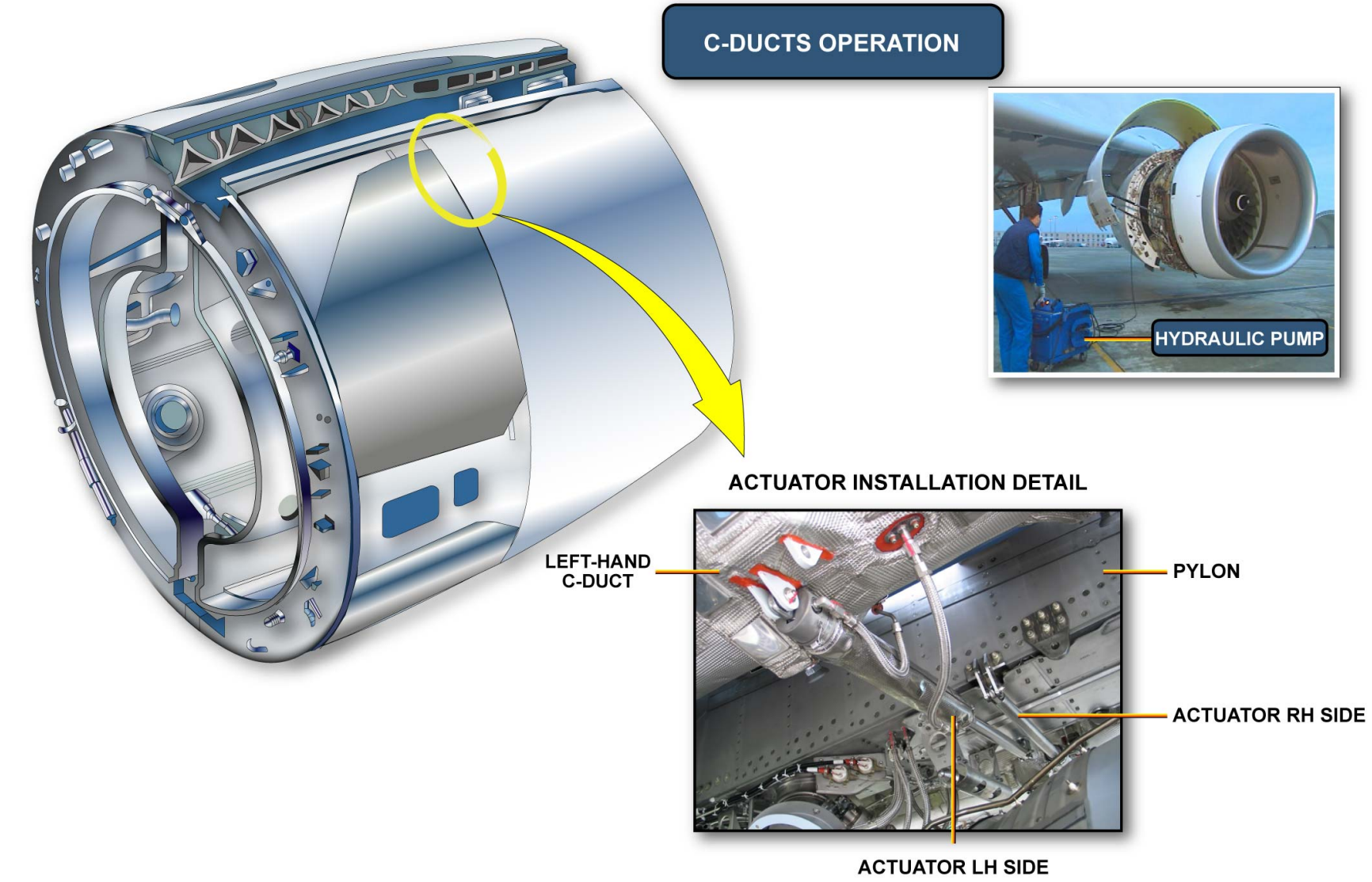
NACELLE D/O (3)

C-DUCT OPERATION

The opening mechanism is designed to hydraulically open and close the thrust reverser cowls.
The thrust reverser opening mechanism is composed of:
- one actuator for each C-duct,
- two hold open rods for each C-duct.

The pressure is supplied by the hydraulic hand pump to extend the actuator.
Actuators are operated until the C-duct is fully open. Once the C-duct is fully open, the hold open rods are installed and the pressure is released. The hold open rods lock automatically and keep the C-ducts open.

NOTE: Note: You must not open the thrust reverser cowls if wind speed is 46 MPH (73 KMH) or more.



C-DUCT OPERATION

ENGINE D/O (3)

GENERAL

The bare engine is an assembly of primary units, which are identified as modules. These modules can be independently replaced in shop and are specified as follows:
- Low Pressure (LP) compressor rotor,
- Intermediate Pressure (IP) compressor,
- intermediate case,
- High Pressure (HP) system (this includes the HP compressor, the combustion system and the HP turbine),
- IP turbine,
- external gearbox,
- LP compressor case,
- LP turbine.

The engine direction of rotation is counterclockwise, the pressure ratio is 37.42:1 and the bypass ratio is 4.66:1.
The weight of the dressed basic engine is 5107 kg (11259 lb) approximately. The engine has different thrust ratings according to different engine version.
The engine hardware is the same and the thrust rating is defined through the Data Entry Plug (DEP).
The DEP is installed and plugged into the Engine Electronic Controller (EEC).

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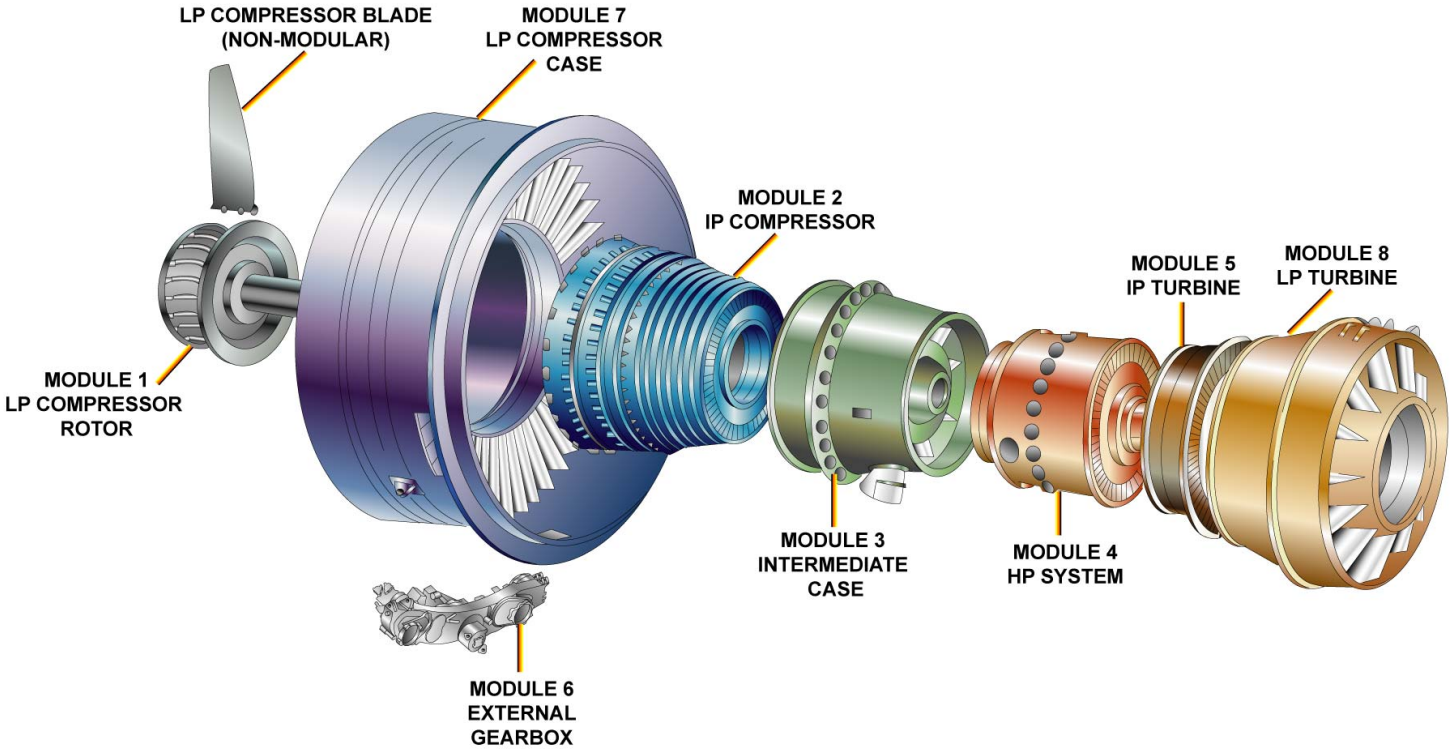
LP COMPRESSOR BLADE
(NON-MODULAR)
MODULE 7
LP COMPRESSOR
CASE
MODULE 2
IP COMPRESSOR
MODULE 5
IP TURBINE
MODULE 8
LP TURBINE
MODULE 1
LP COMPRESSOR
ROTOR
MODULE 3
INTERMEDIATE
CASE
MODULE 4
HP SYSTEM
MODULE 6
EXTERNAL
GEARBOX

GENERAL

ENGINE D/O (3)

ENGINE ROTORS AND MODULES

The three rotating assemblies include:
- the LP Compressor (fan) connected by a shaft to the LP turbine,
- the IP compressor connected by a shaft to the IP turbine,
- the HP compressor connected by a shaft to the HP turbine.

Shafts are supported by ball and roller bearings.

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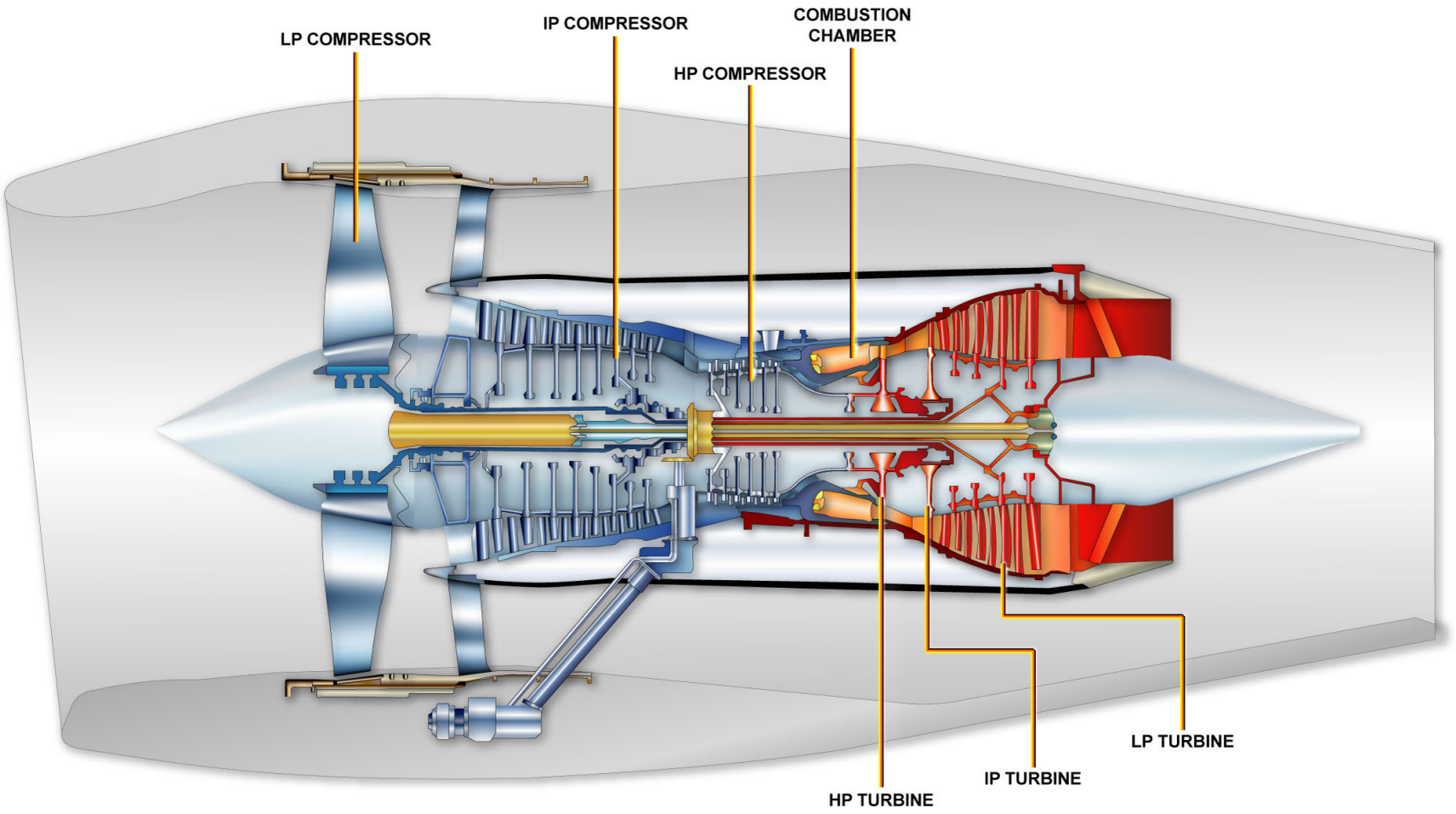

ENGINE ROTORS AND MODULES

GCL13151 - G6RT1DU - FM70D1000000071

ENGINE D/O (3)

ENGINE ROTORS AND MODULES (continued)

LOW PRESSURE COMPRESSOR AND TURBINE

The one stage LP compressor (fan) has 26 wide-chord type blades which are engaged in axial dovetail slots. Each fan blade is held in the disk by two shear keys.

The LP compressor is located in the fan case. The fan case is made of two cylindrical cases, which are connected together with nuts and bolts.

The front part of this assembly contains the LP compressor rotor and the rear part includes the Outlets Guide Vanes (OGVs).

Attached to the outside of the rear part there are many system components, electrical harness and tubes.

The LP compressor shaft connects the fan disk through a curvic coupling that gives the accurate location.

The LP turbine has four disks which are bolted together to make a drum.

The stage 3 disk acts as the drive arm and is attached to the turbine shaft with a curvic coupling.

The LP turbine case supports the rear engine mount.

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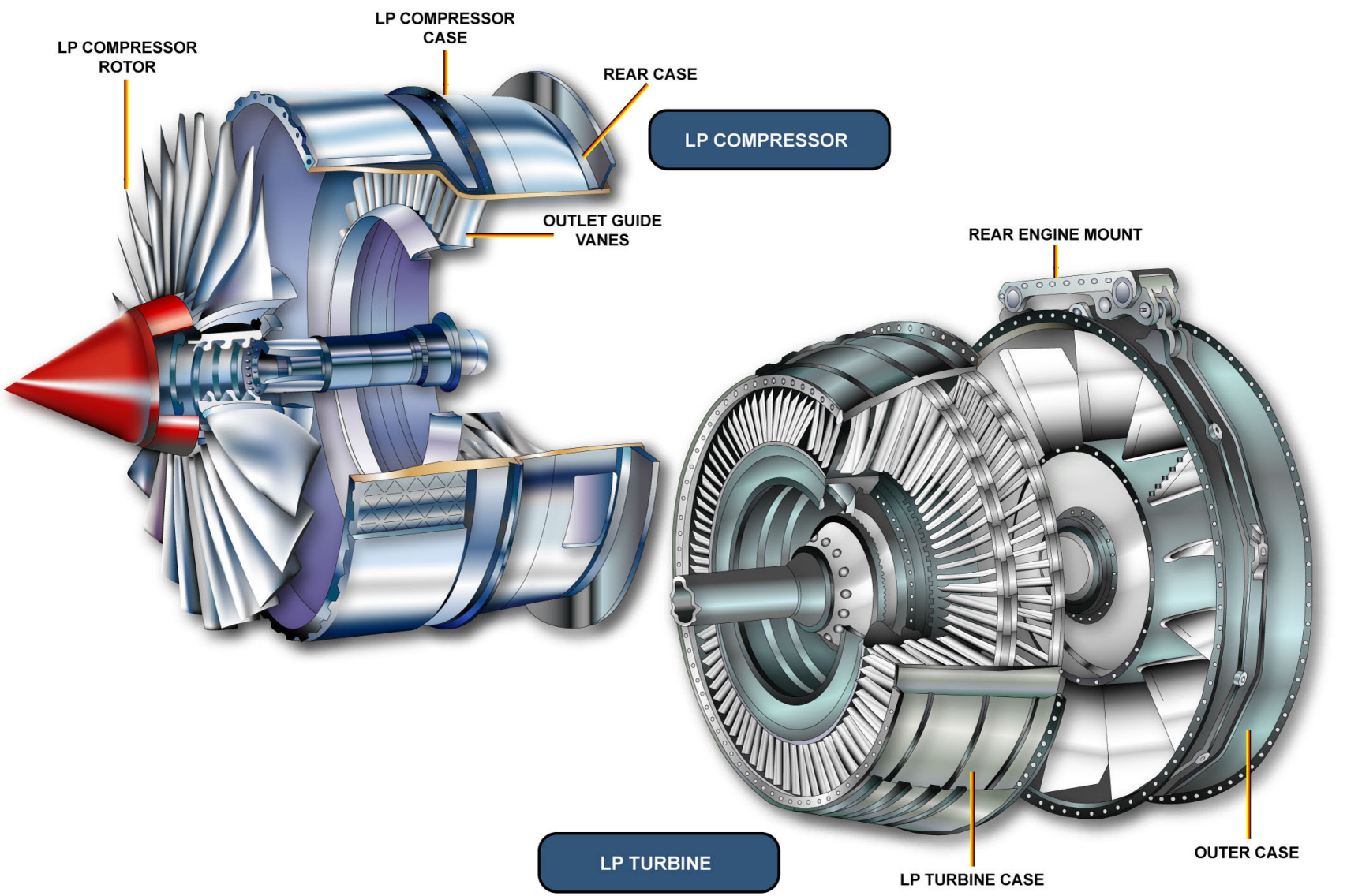

ENGINE ROTORS AND MODULES - LOW PRESSURE COMPRESSOR AND TURBINE

ENGINE D/O (3)

ENGINE ROTORS AND MODULES (continued)

INTERMEDIATE PRESSURE COMPRESSOR AND TURBINE

The IP compressor rotor is an assembly of 8 titanium rotor disks welded together as one drum.
The disks at stages 1 to 6 have axial dovetail slots into which the rotor blades are installed. At stages 7 and 8, the blades are installed in circumferential dovetail slots.
The IP compressor case is divided into two semicircular half cases. The front part contains the Variable Inlet Guide Vanes (VIGVs), the two stages of Variable Stator Vanes (VSVs) and the associated actuating rings. The rear part contains stages 3 to 8 of the compressor stator vanes.
The intermediate case is made from two cylindrical titanium casings welded together.
The front part is installed around the rear part of the IP compressor case and the rear part around the front part of the HP compressor. The front part includes the engine front mount and the rear part includes ten structural vanes to which the internal gearbox housing is connected.
The IP turbine is a single stage turbine assembly. At the hub of the disk a drive arm extends rearwards, and connects the IP turbine shaft and stub shaft by using taper bolts.
The IP turbine shaft runs forward and is connected to the IP compressor stub shaft with helical splines.
In front of the IP turbine there are 26 Nozzle Guide Vanes (NGVs) which are radially installed around the turbine case.
Adjacent to the casing rear flange is a Turbine Case Cooling (TCC) air manifold and the location bosses for 11 thermocouples.

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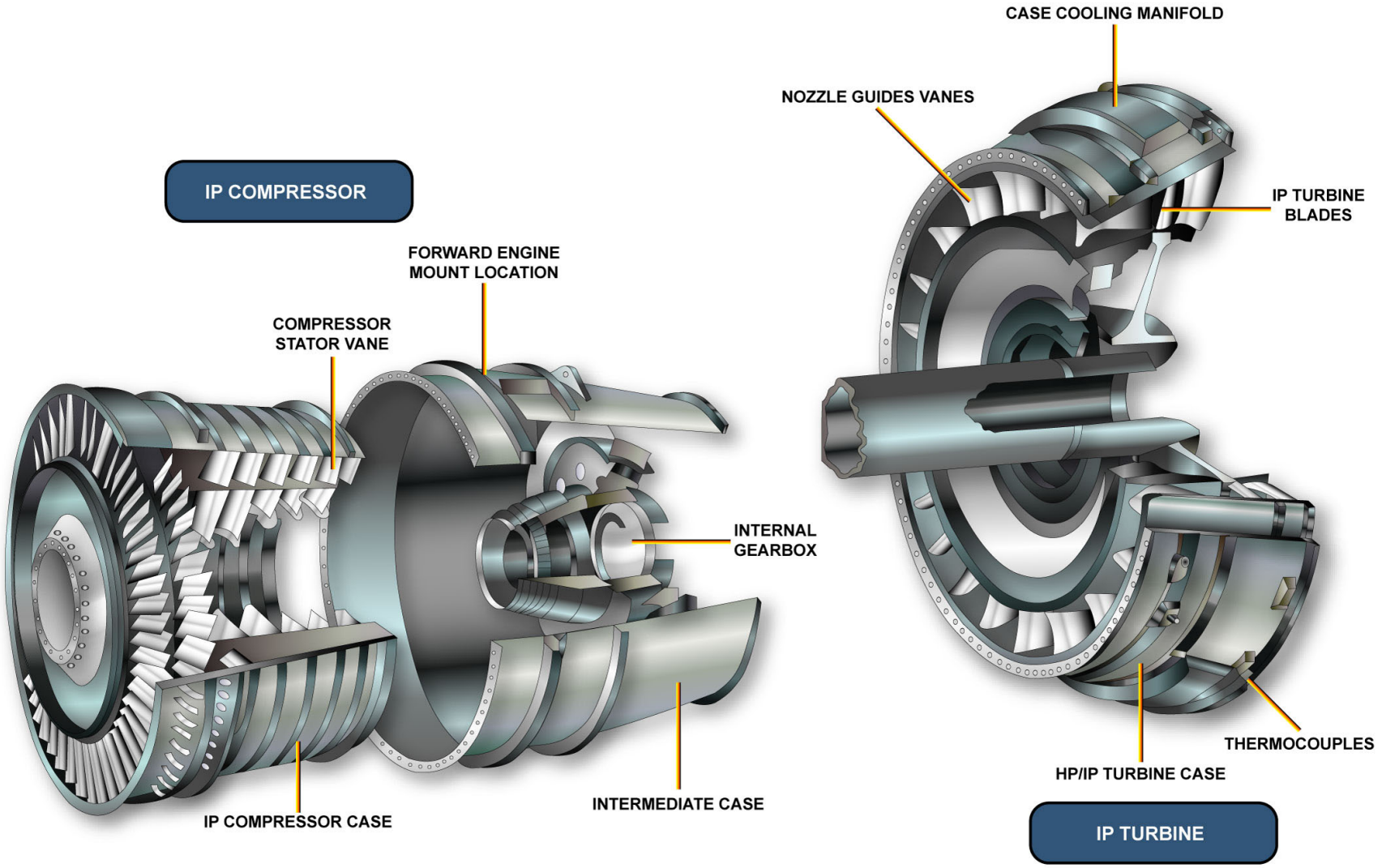

ENGINE ROTORS AND MODULES - INTERMEDIATE PRESSURE COMPRESSOR AND TURBINE

GCL13151 - G6RT1DU - FM70D1000000071

ENGINE D/O (3)

ENGINE ROTORS AND MODULES (continued)

HIGH PRESSURE COMPRESSOR, COMBUSTION CHAMBER AND TURBINE

The HP system includes:
- the HP compressor,
- the combustion chamber,
- the HP turbine.

The HP compressor rotor is a six-stage assembly of titanium disks welded together to make a drum. The first stage blades are installed in axial dovetail slots and are locked with retaining plates. Stage 2 to 6 are installed in circumferential dovetail slots and locked with special nut and screw assemblies.

The HP compressor case is an assembly of 5 flanged cylindrical casings bolted together.

The combustion chamber is fully annular and includes an inner and an outer combustion liners.

24 locations are provided to receive the fuel spray nozzles. There are also 2 igniter plugs installed through bosses in the combustion chamber outer case.

There are 40 NGVs installed at the combustion chamber outlet which are held by a support ring and attached with bolts to the combustion inner case.

The HP turbine is a single stage disk which is attached to the rear of the compressor drum with bolts. On the rear of the disk there is a flange that is attached to a stubshaft. The disk has firtree roots into which fit the turbine blades.

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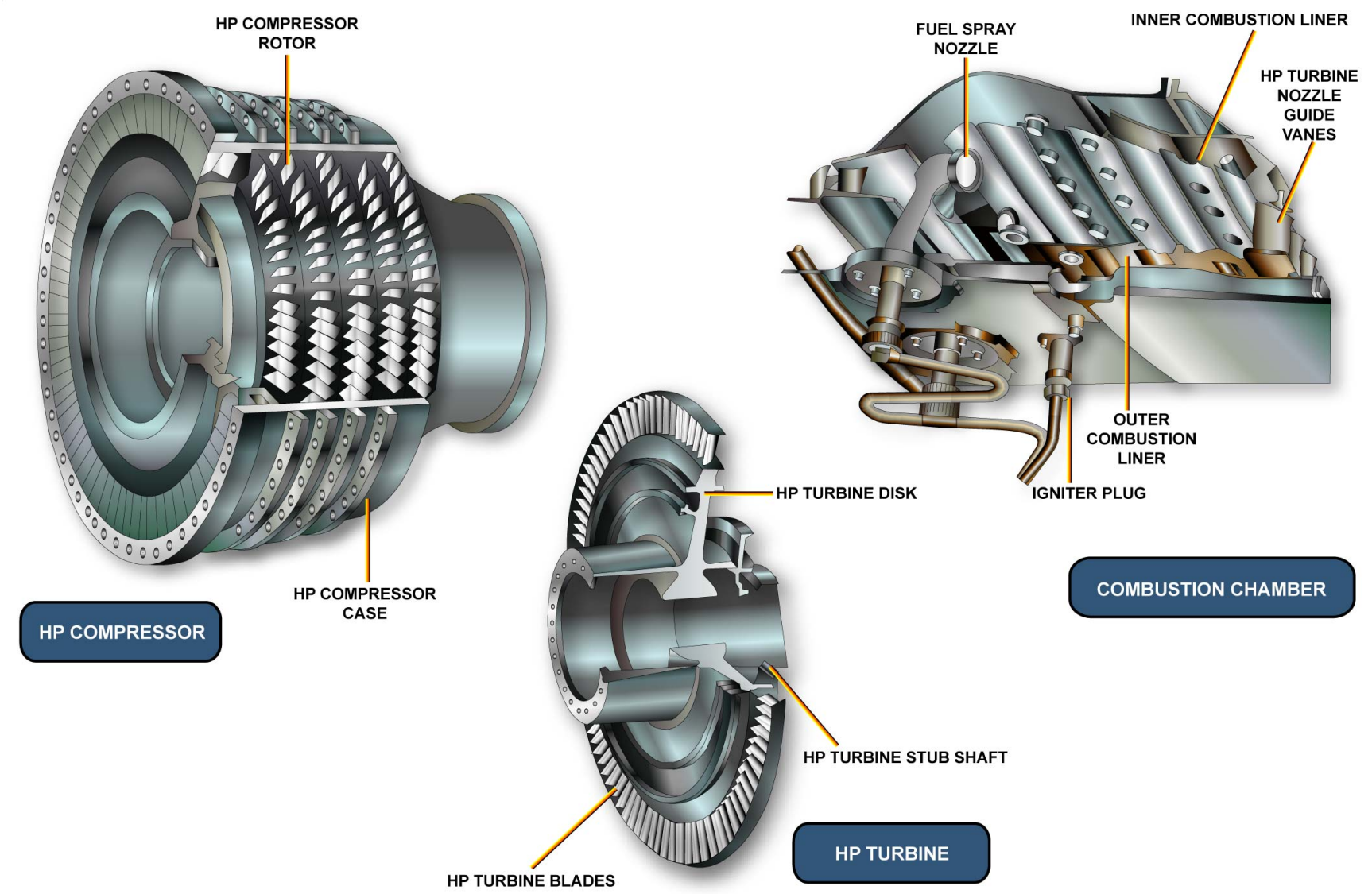

ENGINE ROTORS AND MODULES - HIGH PRESSURE COMPRESSOR, COMBUSTION CHAMBER AND TURBINE

ENGINE D/O (3)

ENGINE ROTORS AND MODULES (continued)

ENGINE BEARINGS

Two types of bearings are used in this engine:
- roller bearings keep the shafts in the correct radial position,
- location thrust ball bearings for all three shafts are positioned in the internal gearbox.

The LP and IP rotor assemblies are each supported by three bearings.
The HP rotor is supported by two bearings.
There are 4 bearing chambers:
- the front bearing chamber includes the LP and the IP roller bearings,
- internal gearbox bearing chamber includes the LP, IP and HP location bearings,
- HP/IP turbine bearing chamber includes the HP and IP turbine roller bearings,
- LP turbine bearing chamber includes the LP turbine roller bearing and the LP turbine spring pack bearing.

Bearing chambers are sealed using IP and HP air and are isolated from other engine parts by labyrinth seals.

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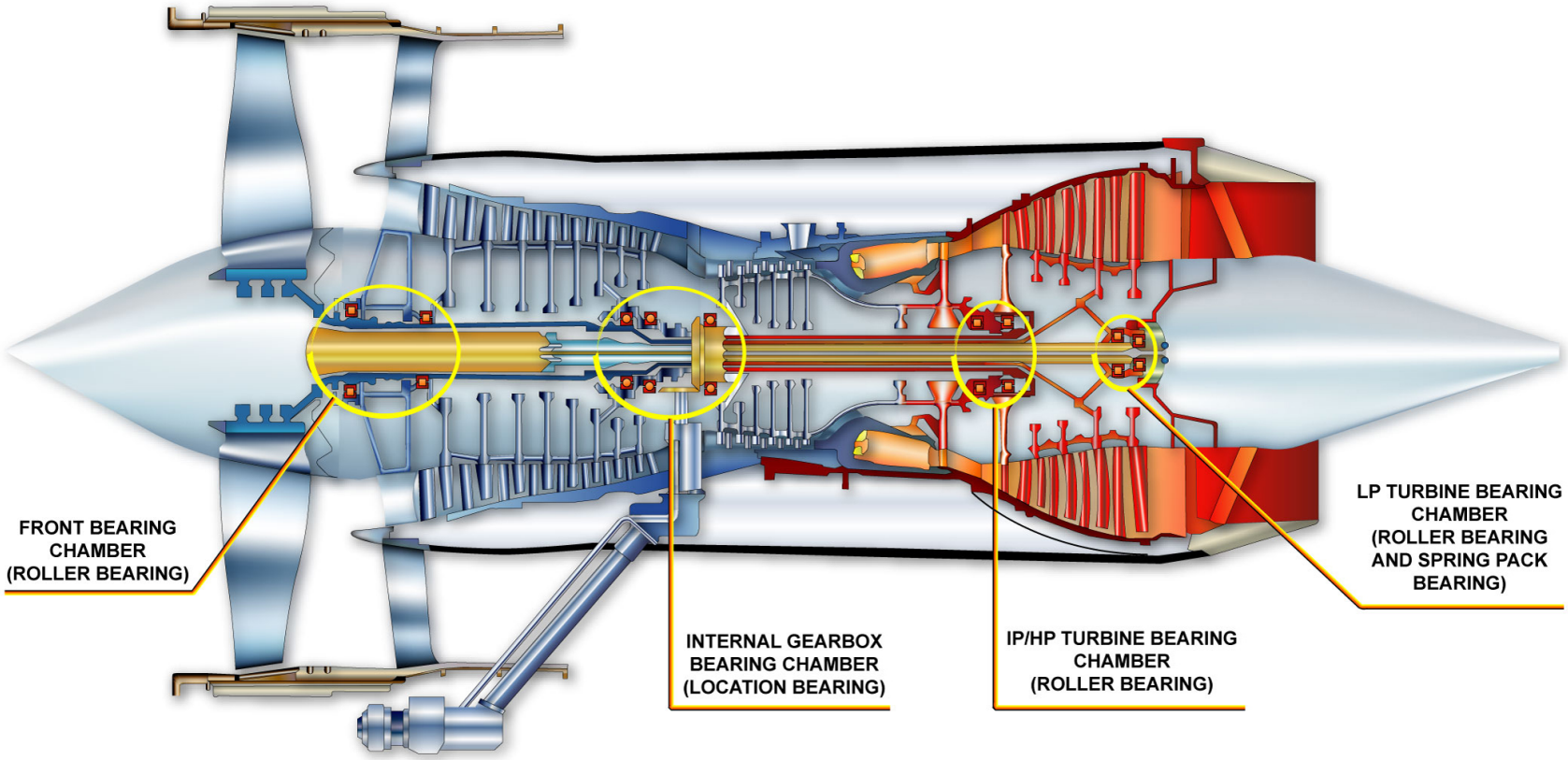
FRONT BEARING CHAMBER (ROLLER BEARING)
INTERNAL GEARBOX BEARING CHAMBER (LOCATION BEARING)
IP/HP TURBINE BEARING CHAMBER (ROLLER BEARING)
LP TURBINE BEARING CHAMBER (ROLLER BEARING AND SPRING PACK BEARING)

ENGINE ROTORS AND MODULES - ENGINE BEARINGS

ENGINE D/O (3)

ACCESORY DRIVE SECTION

The accessory drive section transmits mechanical power from the HP rotor to the accessory units installed on the external gearbox. The drive section is equipped with the following assemblies:
- an internal gearbox,
- an intermediate gearbox,
- an external gearbox drive shaft,
- an external gearbox module.

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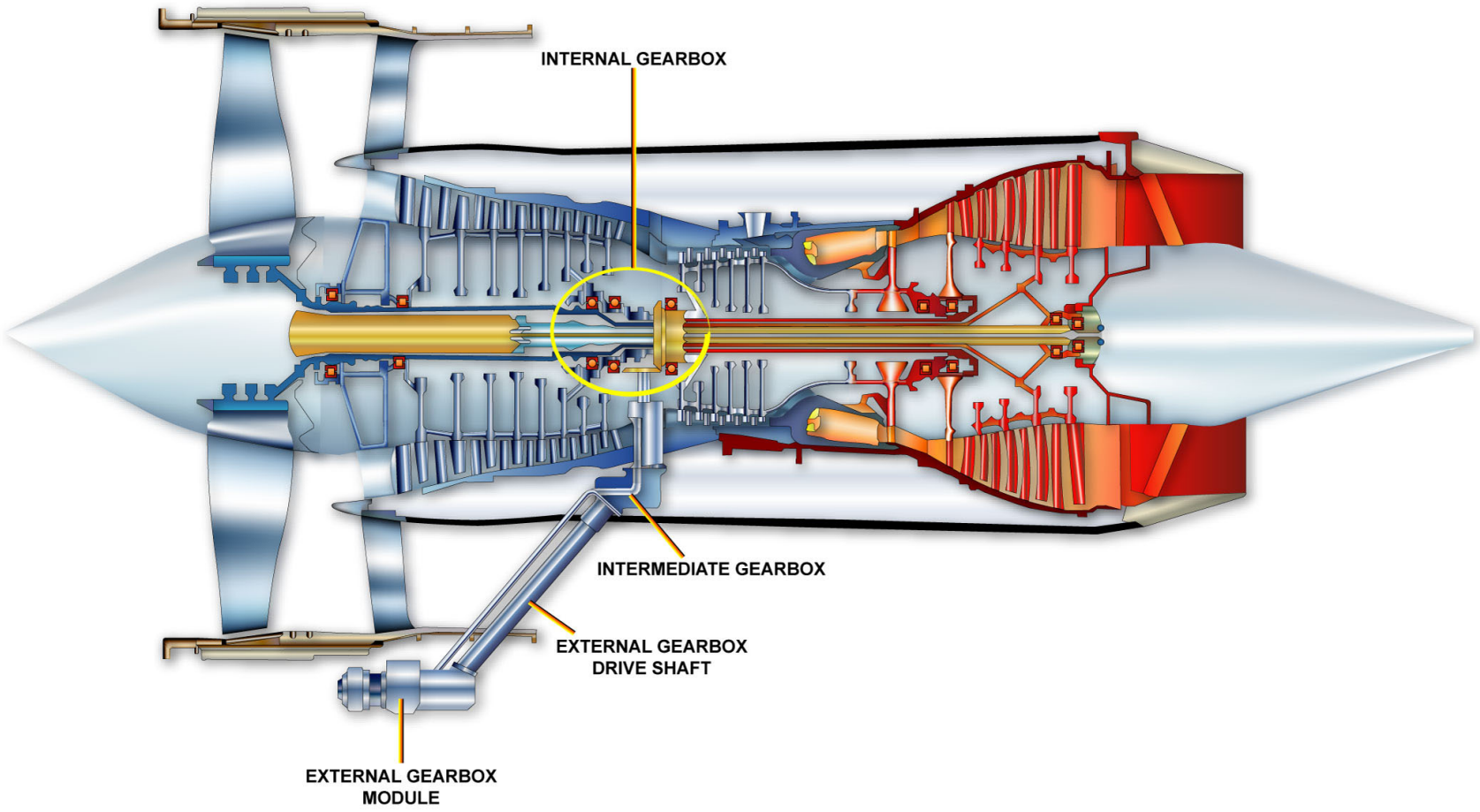


ACCESORY DRIVE SECTION

GCL13151 - G6RT1DU - FM70D1000000071

ENGINE D/O (3)

ACCESORY DRIVE SECTION (continued)

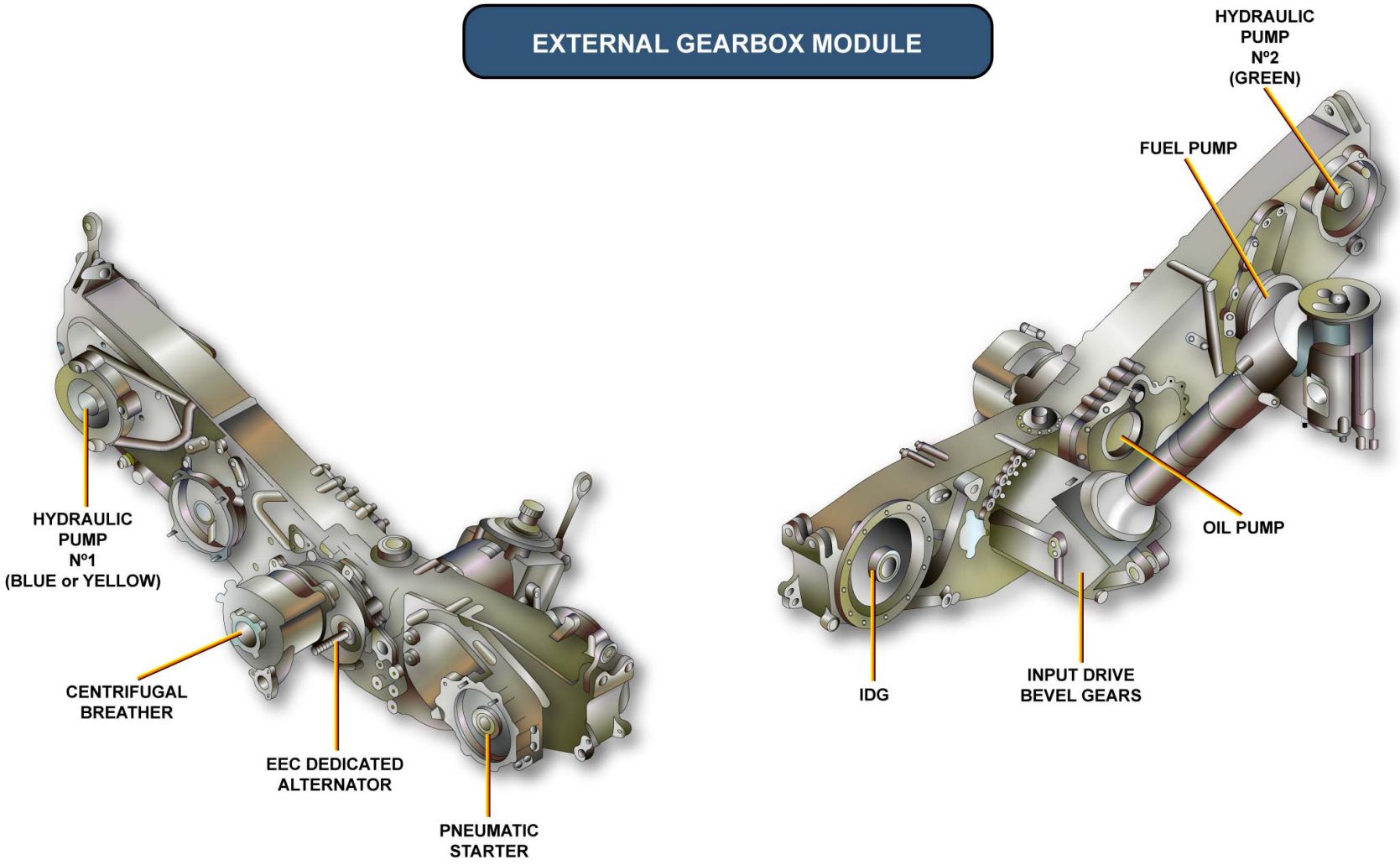
EXTERNAL GEARBOX MODULE

The external gearbox module is an aluminum alloy casting. It is installed below the LP compressor case.
The gearbox transmits power from the engine to drive the accessories mounted on the gearbox front and rear faces.
During starting, the gearbox also transmits power from the air starter motor to the engine.
The components installed on the forward face are:
- pneumatic starter,
- EEC dedicated alternator,
- centrifugal breather assembly,
- hydraulic pump number 1.

The components installed on the rear face are:
- Integrated Drive Generator (IDG),
- input drive bevel gears,
- oil pump,
- fuel pump,
- hydraulic pump number 2.

NOTE: Note: for maintenance purposes, hand turning of the HP rotor system is achieved through the centrifugal breather assembly.

GCL13151 - G6RT1DU - FM70D1000000071



ACCESORY DRIVE SECTION - EXTERNAL GEARBOX MODULE

ENGINE D/O (3)

DRAINS SYSTEM

The drains system has the following functions:
- To remove and discard fuel and/or oil if a leak occurs from an internal seal in specified primary components. The drains system can be used to monitor the condition of these seals.
- To remove and discard all unwanted liquids collected in the pylon, cowls and fairings.
- To collect unburned fuel from the combustion chamber following an engine shut down or a start procedure not completed.

Leaks from the accessories are drained overboard via a drains mast.
The items that are connected to the drains mast are:
- the Air Oil Heat Exchanger (AOHE),
- the hydraulic pump number 1,
- the hydraulic pump number 2,
- the LP/HP fuel pumps,
- the Fuel Metering Unit (FMU),
- the pneumatic starter,
- the IDG,
- the VSV actuators,
- the drain collector tank, and
- the oil tank.

NOTE: Note: the two VSV actuators, the AOHE and the FMU are connected to the same drain outlet at the drains mast, as well as the IDG and the starter. But the drain tube from each actuator, the AOHE and the IDG have a sump for better source leak detection.

Other tubes in the drains system remove unwanted fluids from the pylon primary structure, from the area behind the core fairings and from the LP turbine area.

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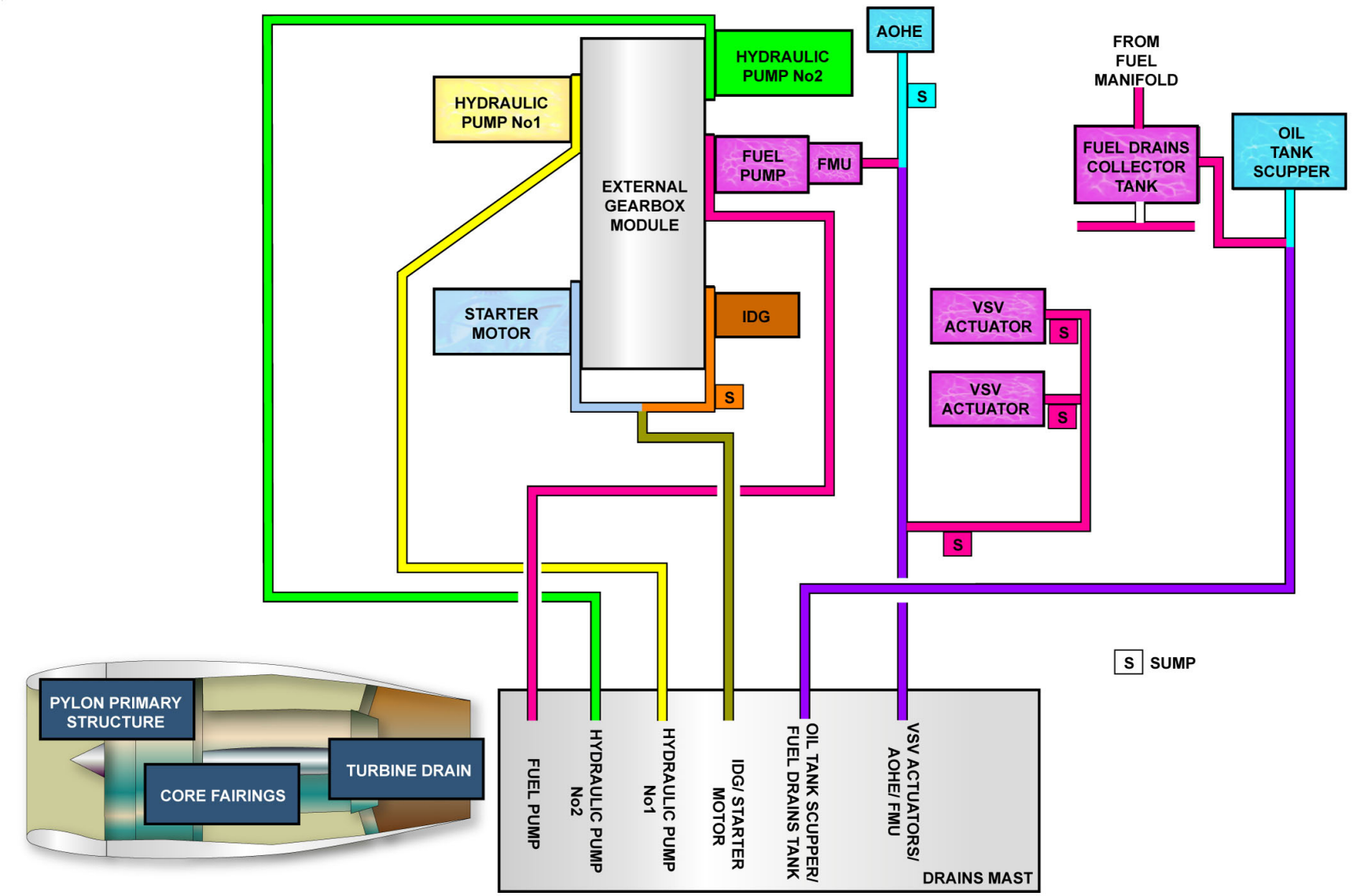

DRAINS SYSTEM

GCL13151 - G6RT1DU - FM70D1000000071

ENGINE D/O (3)

DRAINS SYSTEM (continued)

DRAINS MAST

The drains mast has six outlets for the routing of drained fluids overboard and is installed on the forward face of the external gearbox module adjacent to the collector tank.
The related components from each drain outlet are identified on the side of the drains mast.

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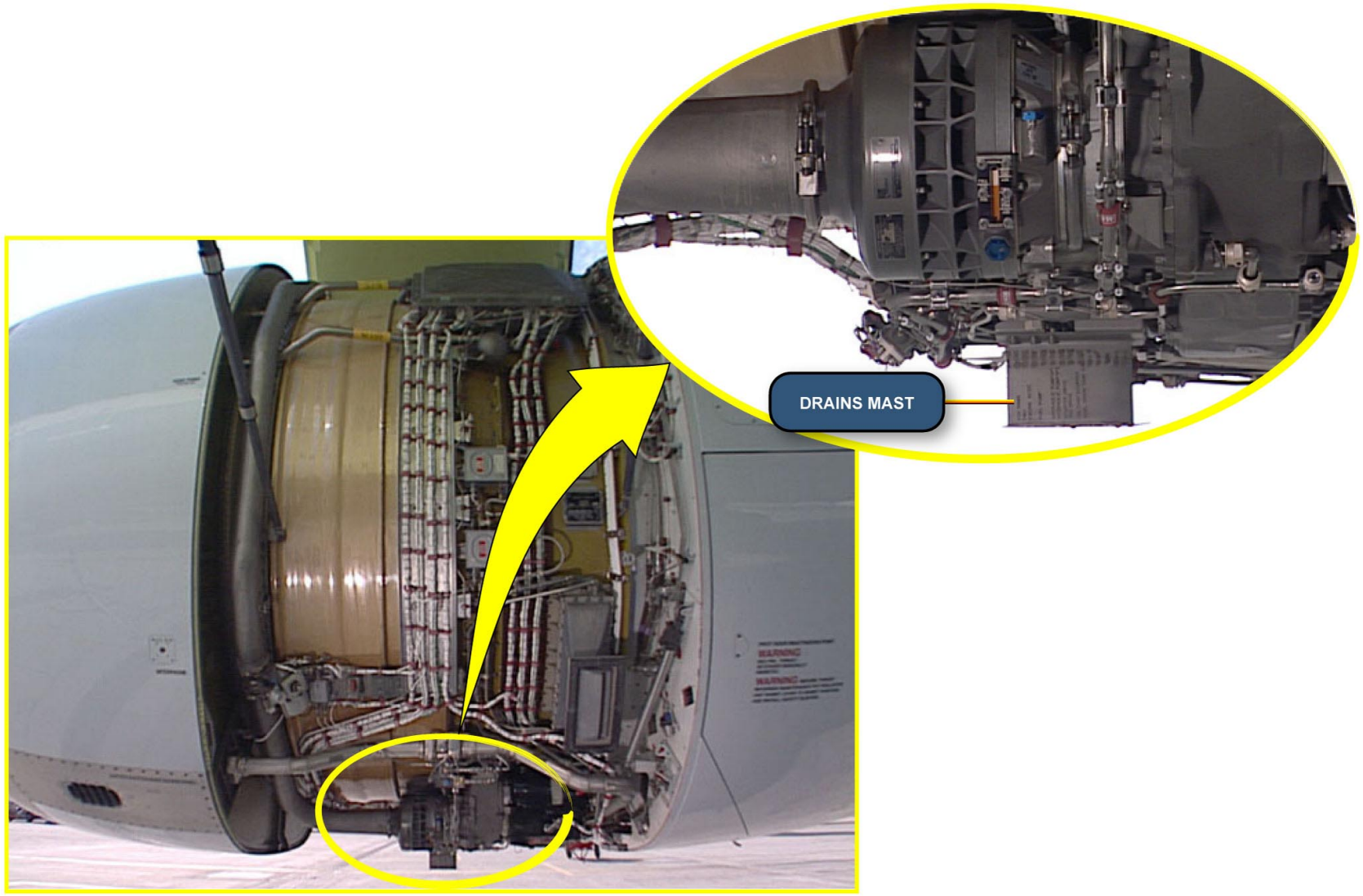


DRAINS SYSTEM - DRAINS MAST

GCL13151 - G6RT1DU - FM70D1000000071

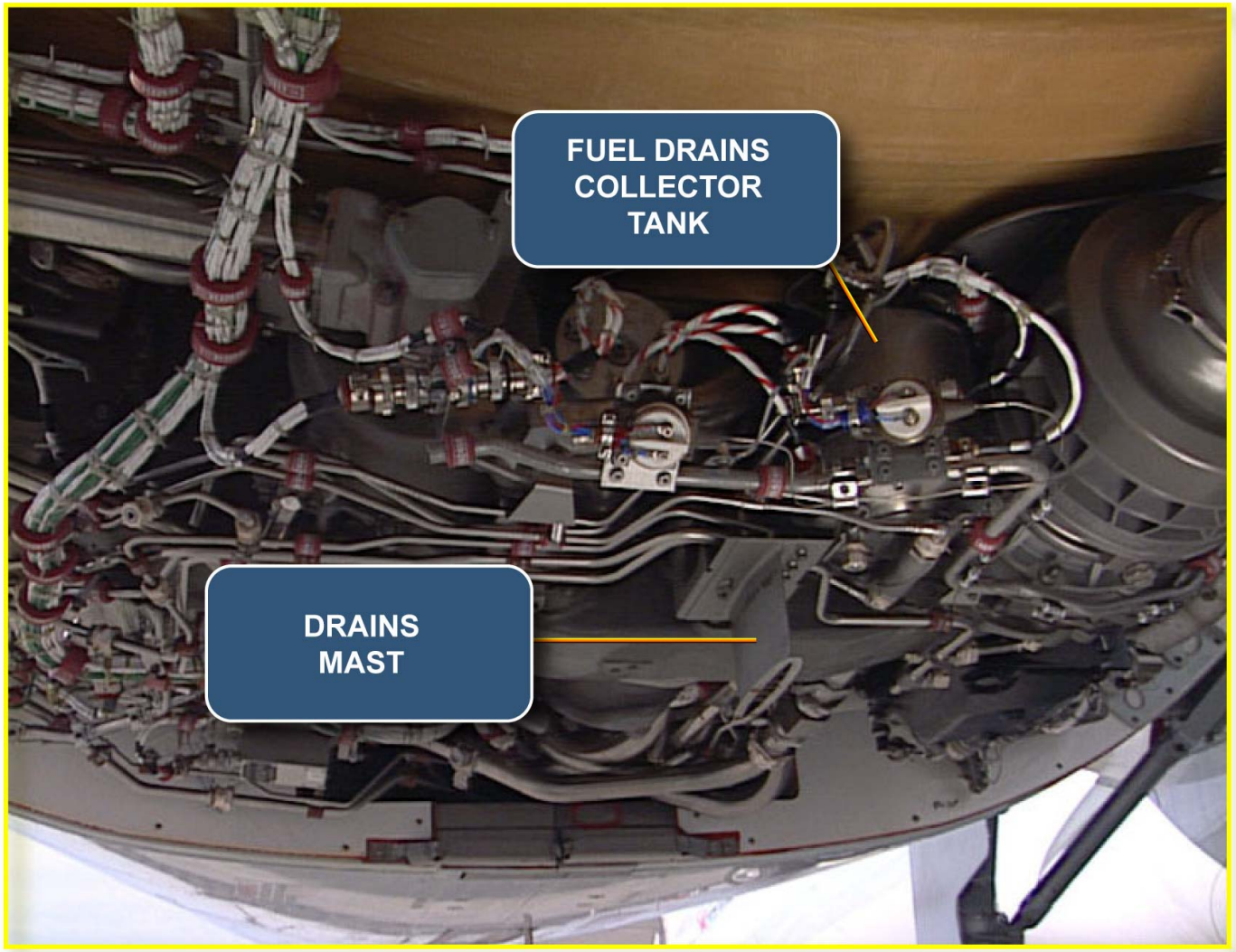
ENGINE D/O (3)

DRAINS SYSTEM (continued)

DRAINS COLLECTOR TANK

The drain system has also a drains collector tank / ejector assembly which is installed on the forward face of the external gearbox module and connected to the drains mast too.
The tank collects excessive and unused fuel that drains from the fuel manifold when the engine is shut-down or after an engine start abort.
The ejector sends the fuel back to the LP fuel system during engine start.
If the tank is full, the fuel is discarded overboard via the drains mast.

GCL13151 - G6RT1DU - FM70D1000000071



DRAINS SYSTEM - DRAINS COLLECTOR TANK

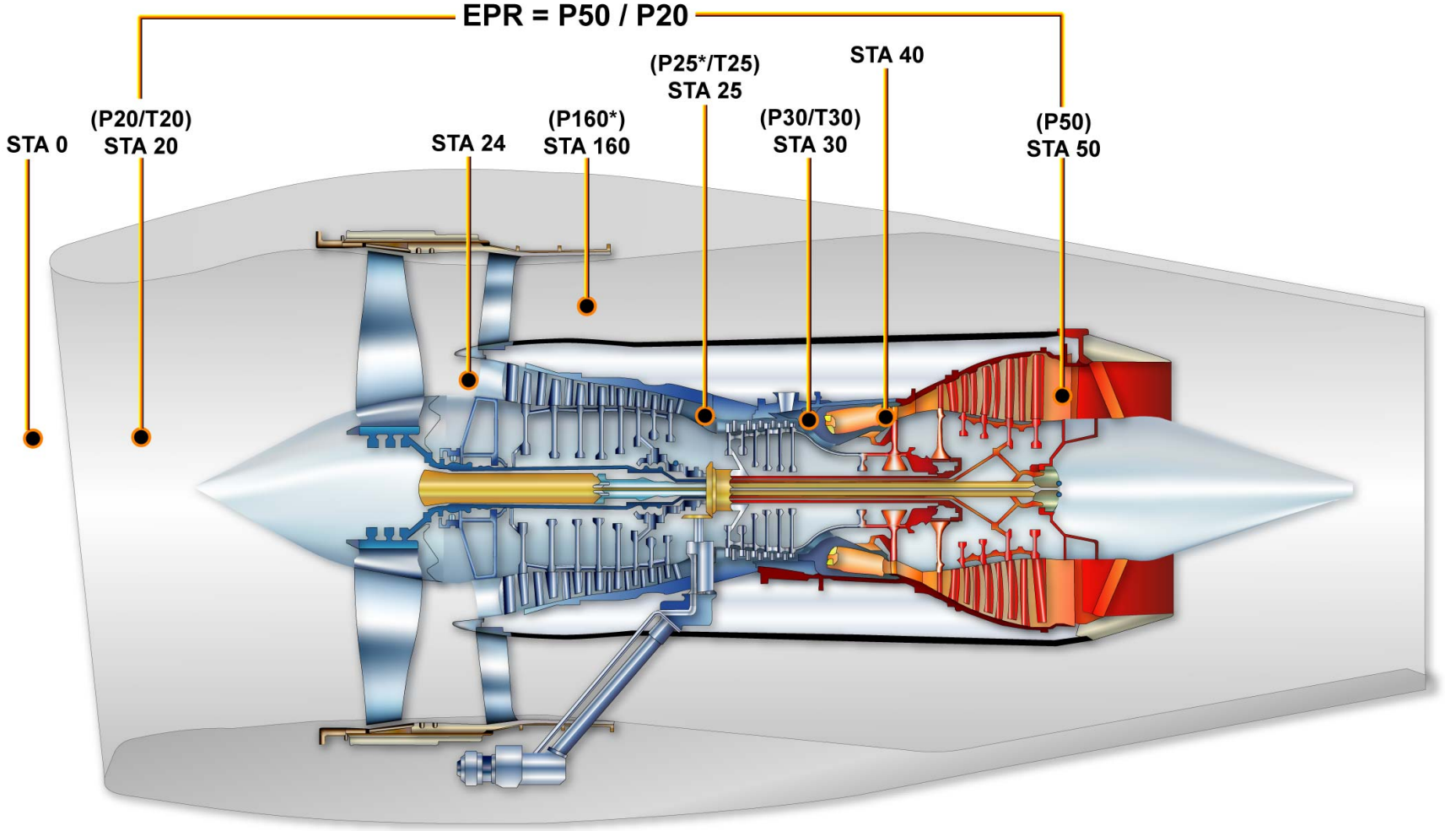
ENGINE D/O (3)

AERODYNAMIC STATIONS

Engine parameters are measured at various stations throughout the engine.
The stations can be described as follows:
- 0 In front of intake lip (atmospheric),
- 20 Inlet to LP compressor (fan) (P20/T20),
- 24 Inlet to IP compressor,
- 25 Inlet to HP compressor (P25*/T25),
- 30 Exit from HP compressor (P30/T30),
- 40 Exit from combustion chamber,
- 50 Exit from LP turbine (P50),
- 160 Fan stream (by-pass) (P160*).

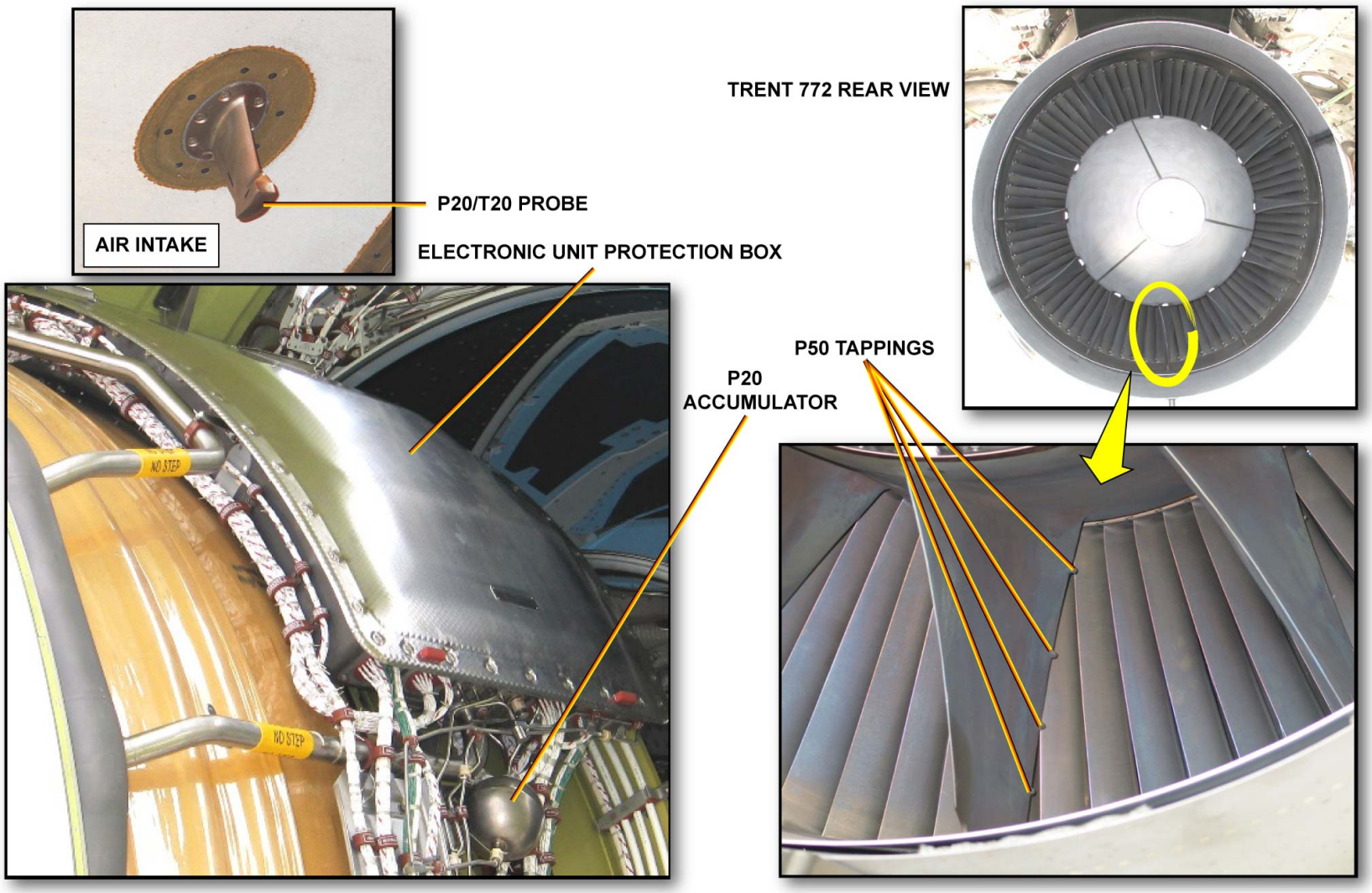
The Exhaust Gas Temperature (EGT) is measured at the inlet to the LP turbine, which corresponds to station 49.5. Eleven thermocouples are installed approximately equally around the engine within the LP1 turbine nozzle guide vanes and transmits EGT signal to the EEC..

GCL13151 - G6RT1DU - FM70D1000000071

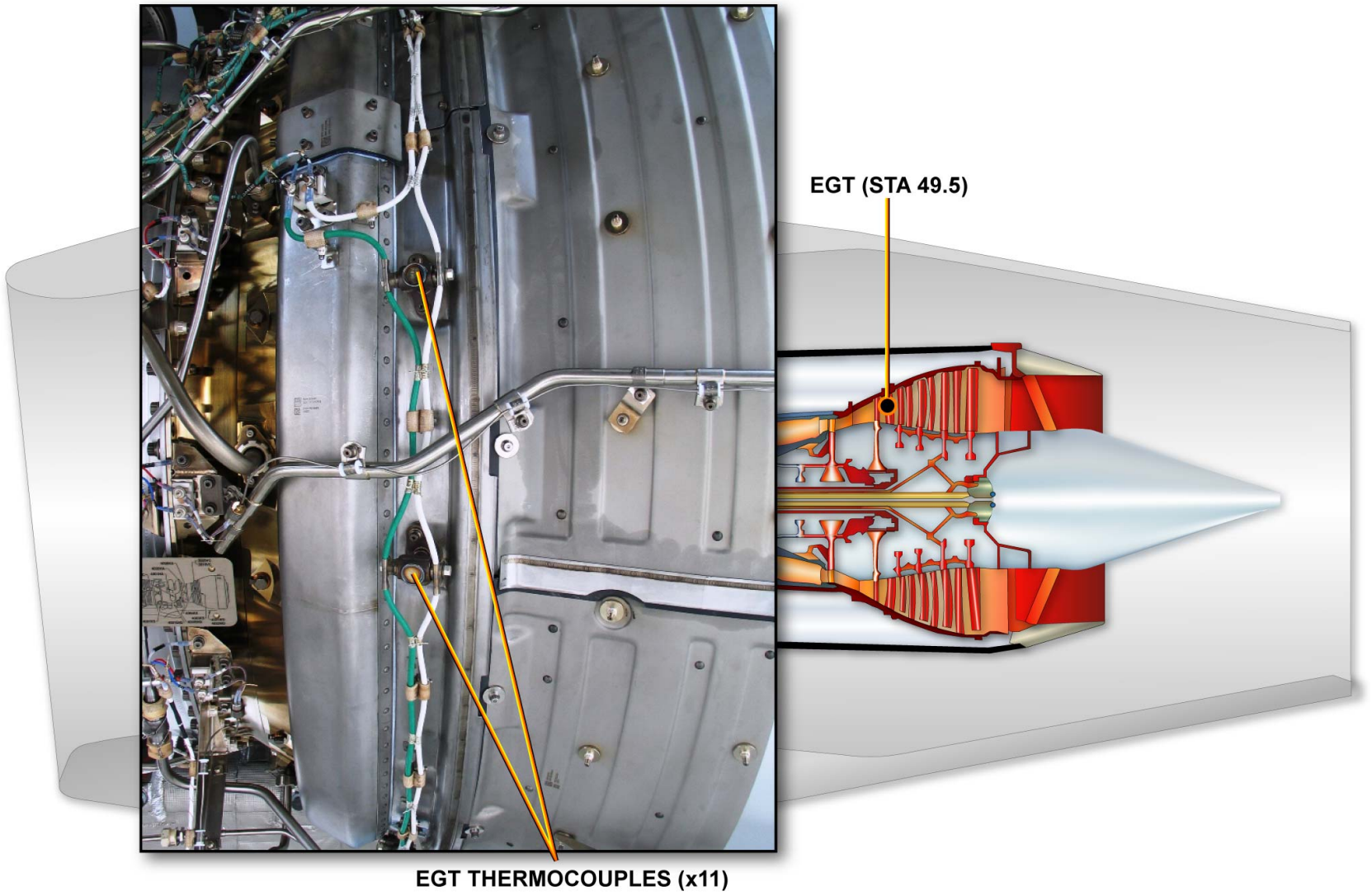


AERODYNAMIC STATIONS

GCL13151 - G6RT1DU - FM70D1000000071



AERODYNAMIC STATIONS



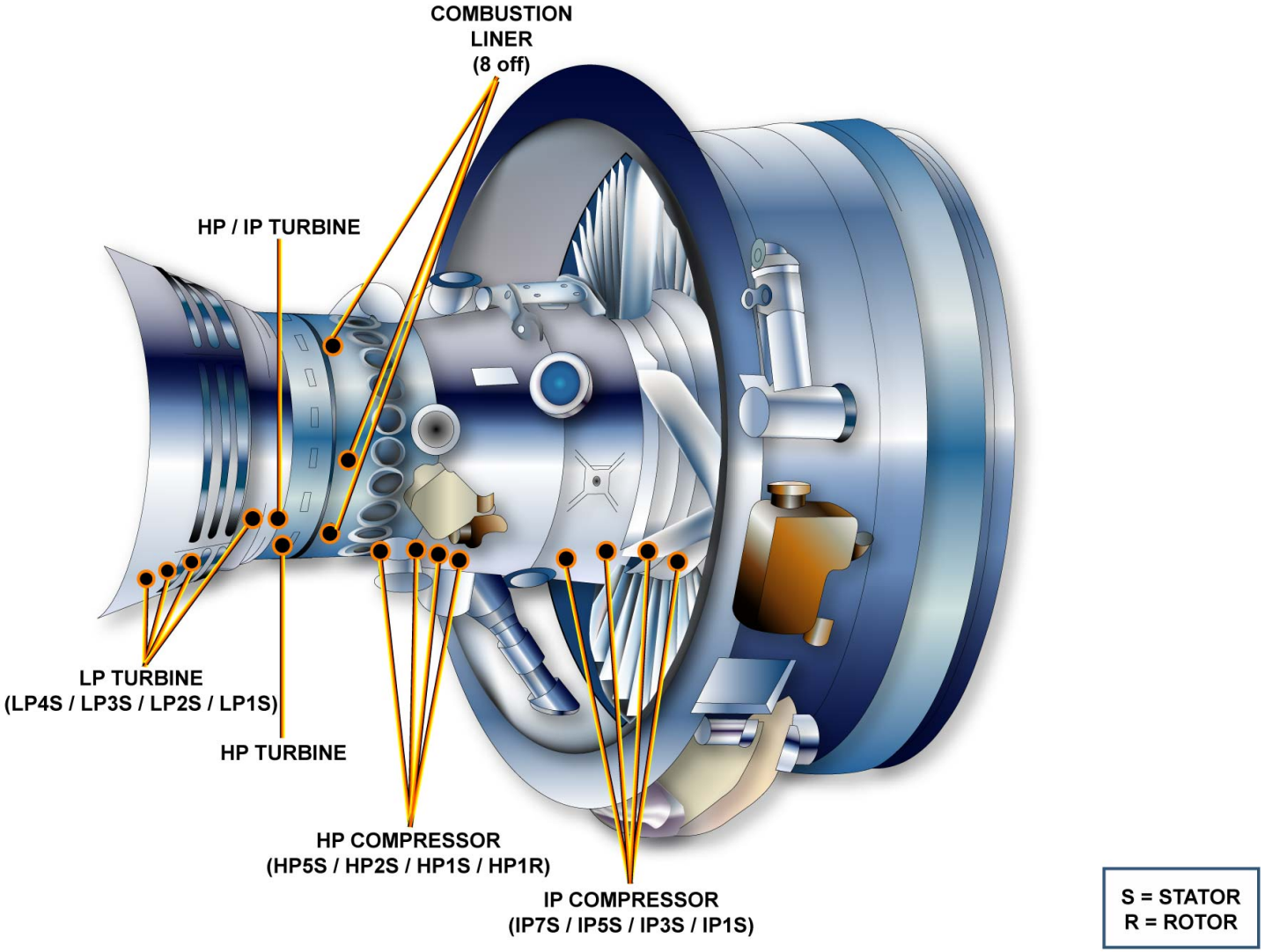
AERODYNAMIC STATIONS

ENGINE D/O (3)

BORESCOPE ACCESS PORTS

It is possible to visually examine the engine at different positions by the use of borescope equipment.
There are 4 borescope access ports on the IP compressor case. They are located on the right side with access via the right thrust reverser half and right bottom gas generator fairing.
The HP compressor has 4 borescope access ports.
They are located on the compressor case, on the lower right hand side, with access via the right thrust half reverser.
There are 8 combustion chamber access ports located radially around the combustion outer case. Three of these access ports are occupied by T30 thermocouples. The 2 igniter ports could be used as borescope ports.
There are 2 access ports to view the HP turbine.
They are both located on the lower right hand side of the core, one on the HP turbine case, the other on the IP turbine case.
There are 2 access ports to view the IP turbine located on the lower right hand side of the core.
The one on the IP turbine case lets the IP turbine blade leading edge be seen.
The front access port on the LP turbine lets the IP turbine trailing edge be seen.
There are 4 access ports on the LP turbine case, lower right hand side to view the LP turbine assembly.

GCL13151 - G6RT1DU - FM70D1000000071



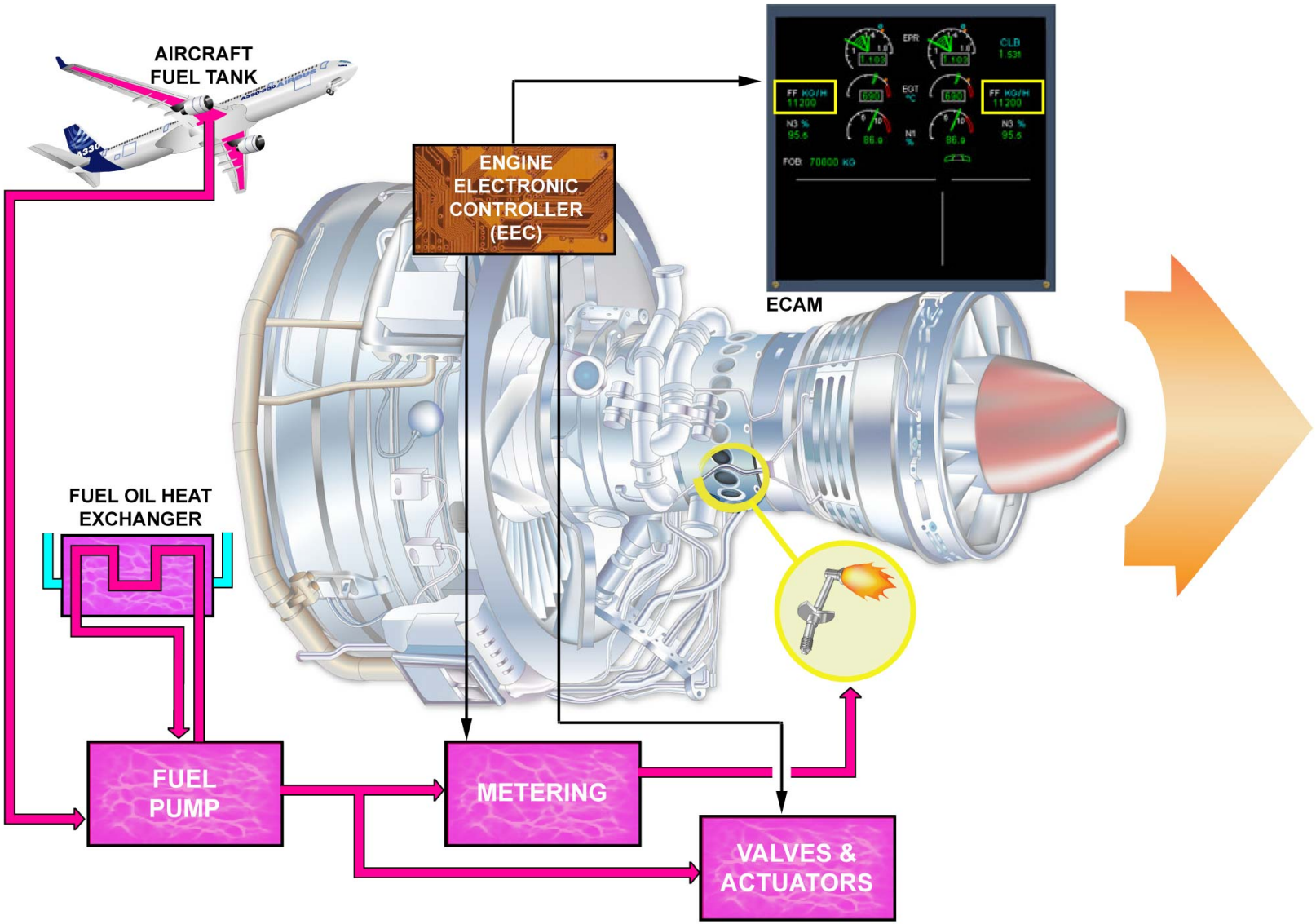
BORESCOPE ACCESS PORTS

ENGINE FUEL SYSTEM D/O (3)

GENERAL

The engine fuel system is designed to supply metered fuel to the combustion chamber according to the engine power demand. The fuel system is also used to cool the engine oil and supply servo pressure to operate valves and actuators.
The Engine Electronic Controller (EEC) controls the operation of the engine fuel system. The EEC also monitors the system for normal operation and ECAM fuel flow indication.

GCL13151 - G6RT1DU - FM70D3000000071


AIRCRAFT
FUEL TANK
ENGINE
ELECTRONIC
CONTROLLER
(EEC)
ECAM
FUEL OIL HEAT
EXCHANGER
FUEL
PUMP
METERING
VALVES &
ACTUATORS

GENERAL

ENGINE FUEL SYSTEM D/O (3)

GENERAL (continued)

LOW PRESSURE FUEL

The low pressure (LP) valve controls the fuel supply from the aircraft tanks to the engine fuel pump. The engine fuel pump includes an LP pump and an HP pump. Fuel from the tanks is initially supplied to the LP pump.
From the LP fuel pump fuel is supplied to the Fuel Oil Heat Exchanger (FOHE) for fuel heating and oil cooling.
Then the fuel goes through the LP fuel filter.

HIGH PRESSURE FUEL

The filtered LP fuel is returned to the high-pressure (HP) fuel pump. The HP fuel pump pressurizes the fuel and supplies the Fuel Metering Unit (FMU), the Variable Stator Vane (VSV) actuators and the Air Oil Heat Exchanger (AOHX) modulating valve. The FMU, which contains servo valves, is mounted below the fuel pump assembly.
A metering valve in the FMU adjusts the fuel flow delivered to the combustion chamber. This fuel flow, from the FMU, successively goes through the fuel flow transmitter and the HP fuel filter before supplying the fuel manifolds and Fuel Spray Nozzles (FSNs).
A Pressure Raising and Shut-Off Valve (PRSOV), installed inside the FMU downstream of the metering valve, starts or stops the fuel flow and keeps the fuel at a satisfactory pressure.
An overspeed valve in the FMU can close the PRSOV in case of N1, N2 or LP turbine overspeed.

CONTROL

Before engine start, the MASTER switch is OFF, the LP valve and the PRSOV are closed.
When the MASTER switch is set to ON, the LP valve opens and the EEC controls the PRSOV to open by.

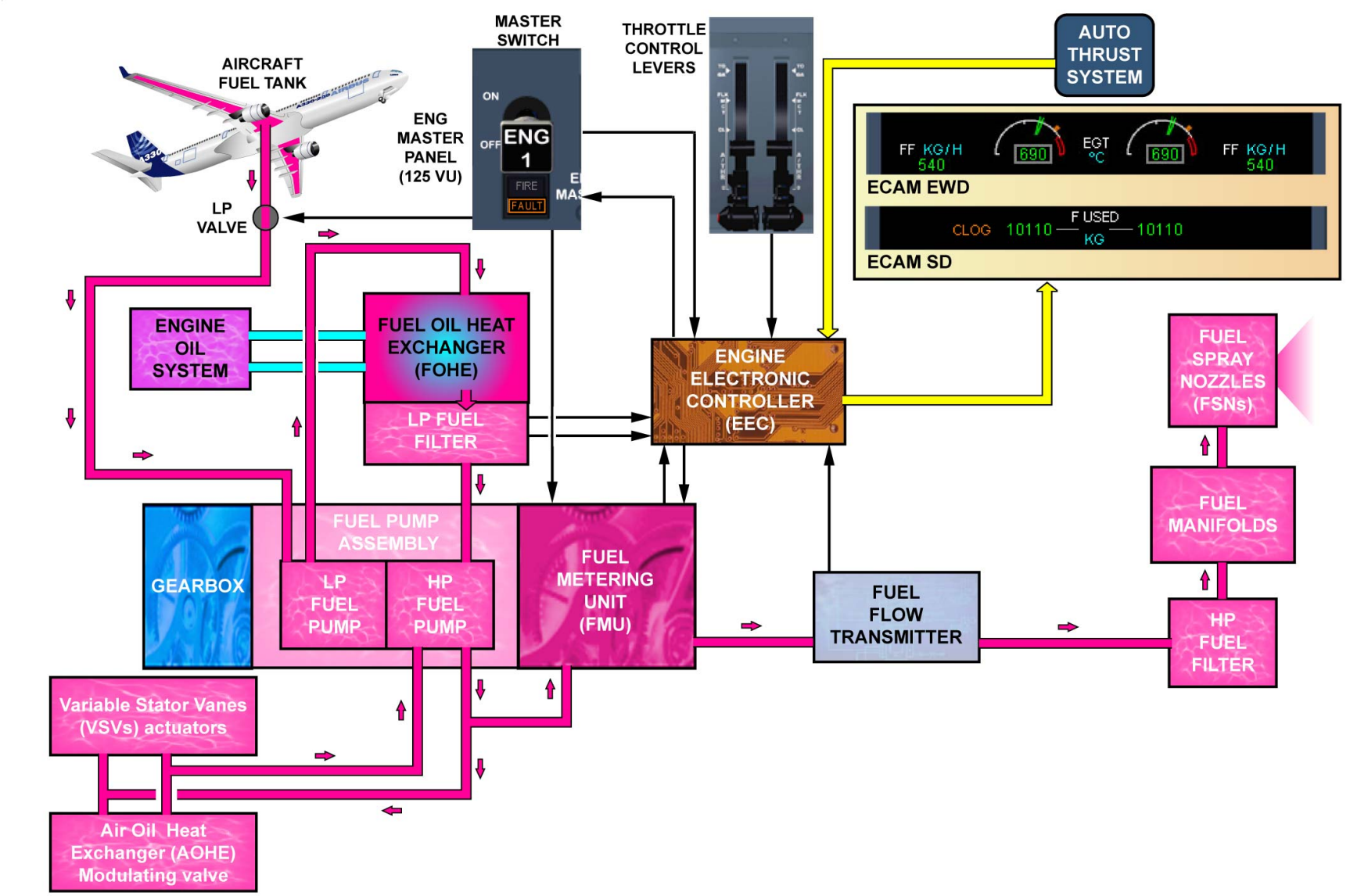
The EEC controls the fuel flow through the metering valve in response to the throttle control lever demand or to the auto thrust system command.
Engine normal shut down is done by setting the MASTER switch on OFF which closes the LP valve and the PRSOV directly. The EEC can also close the PRSOV automatically in case of automatic start abort on ground.

MONITORING

For fuel system monitoring and ECAM indication, the EEC uses the following sensors:
- the fuel flow transmitter for fuel flow and fuel used indications,
- the LP fuel filter differential pressure switch for filter clogging indication,
- the fuel low pressure switch for fuel pressure monitoring.

To monitor the metering valve and the PRSOV positions, the EEC uses sensors inside the FMU.

GCL13151 - G6RT1DU - FM70D3000000071



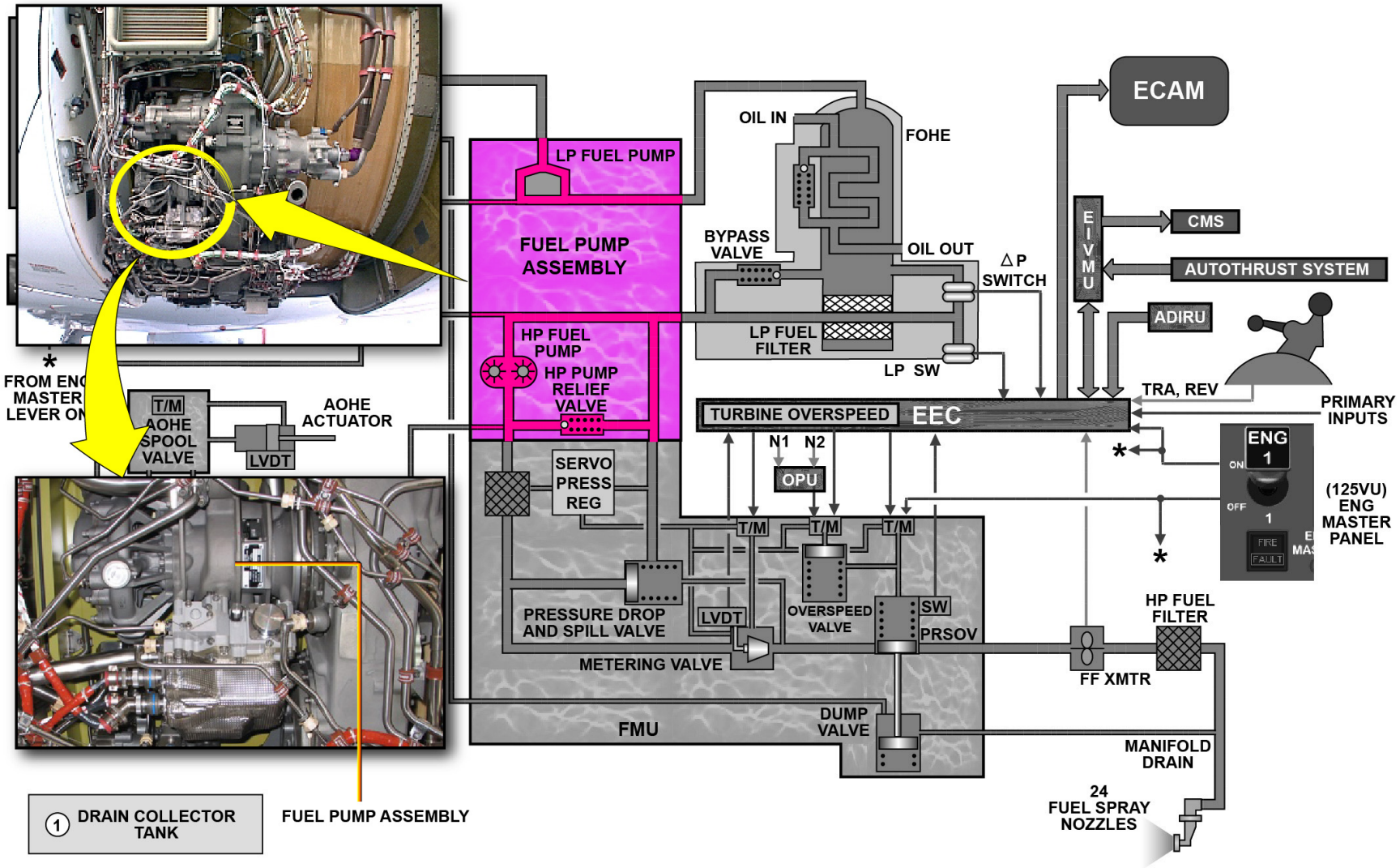
GENERAL - LOW PRESSURE FUEL ... MONITORING

ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - FUEL PUMP ASSEMBLY

The engine fuel pump assembly is driven from the external gearbox and is mounted on the gearbox rear face at the RH side. This assembly includes a LP pump, an HP pump and an HP pump relief valve.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - FUEL PUMP ASSEMBLY

ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - LOW PRESSURE FUEL FLOW

LP PUMP

The LP pump has a single-stage centrifugal impeller with an axial inducer. The fuel from the tanks is delivered to the LP pump under aircraft boost pump pressure and the LP pump increases that pressure before supplying fuel to the HP pump. The LP pump behaves as a suction pump in case of a "gravity feed" situation (boost pumps failed).

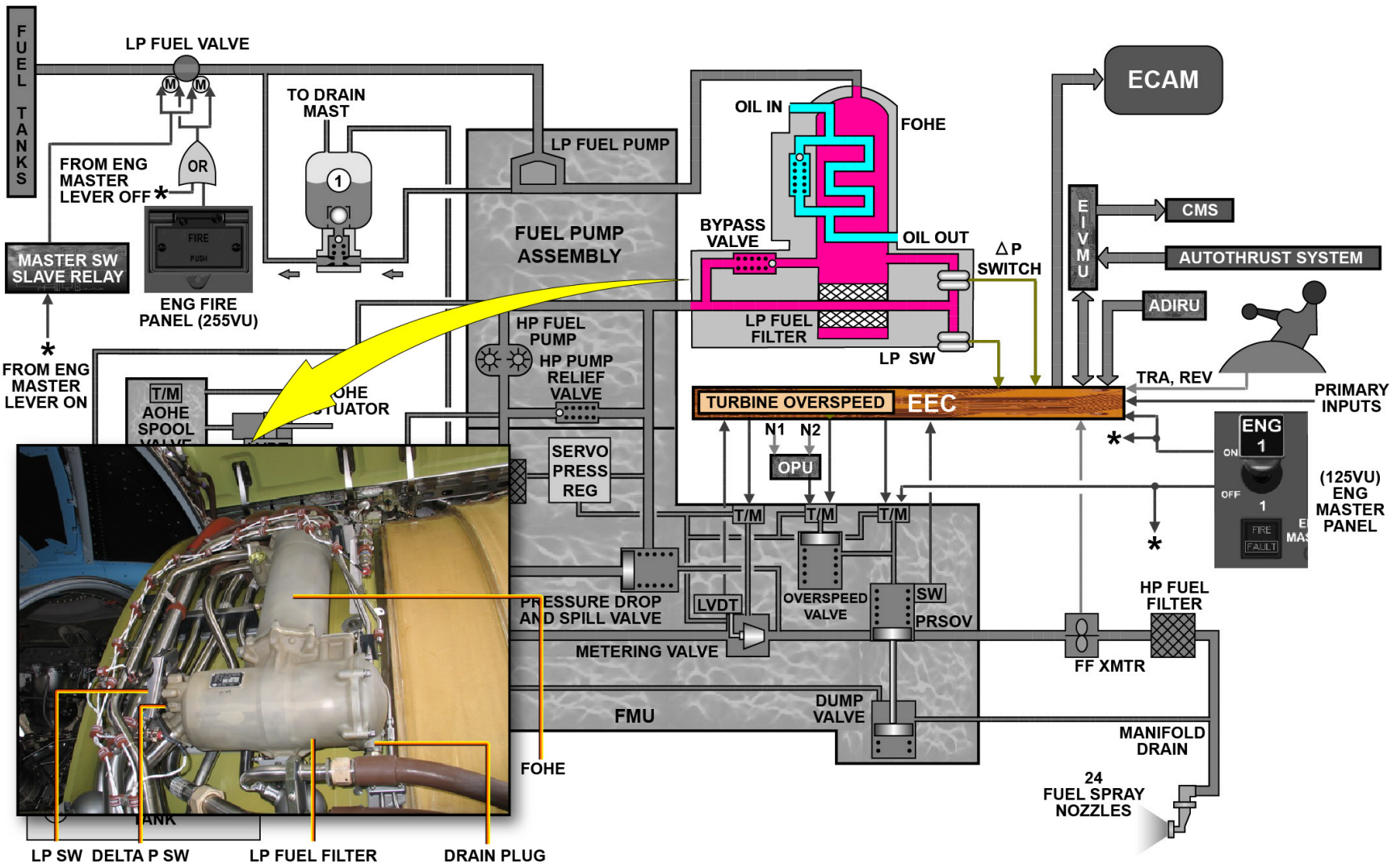
FOHE

The Fuel Oil Heat Exchanger (FOHE) and the LP fuel filter are included in the same assembly and are installed on the RH side of the LP compressor case.
The FOHE is installed in the upper part of the assembly. Its function is to both reduce the engine oil temperature and to prevent the icing of the moisture in the fuel.
The fuel enters the FOHE at the upper part, flows through the inner core via a cluster of tubes, then directly supplies the LP fuel filter.
The engine oil flows through the inner core via a stack of baffle plates.

LP FUEL FILTER

The LP fuel filter is installed in the lower part of the assembly. It is the primary filter in the distribution system. The filter element is disposable. A fuel drain plug is installed in the cap so that the case can be drained of fuel when the access to the filter is necessary.
The LP fuel filter includes a fuel by-pass valve, a differential pressure (P) switch and a fuel LP switch installed downstream of the filter.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - LOW PRESSURE FUEL FLOW - LP PUMP ... LP FUEL FILTER

GCL13151 - G6RT1DU - FM70D3000000071

ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - HIGH PRESSURE FUEL

HP PUMP

The HP pump is a gear-type pump and is protected against overpressure by a relief valve. The fuel from the FOHE and the LP fuel filter, is supplied to the HP pump.
The HP pump supplies the FMU with high-pressure fuel. The HP pump also re-circulates the excess spill flow from the metering valve.

FUEL METERING UNIT - FMU

The FMU is attached to the lower surface of the fuel pump assembly and has two internal fuel connections, one for the HP supply and the other for fuel spill. The main function of the FMU is to supply metered fuel to the nozzles for combustion. The FMU is the Line Replaceable Unit but it contains several different components.
The FMU contains these components:
- the metering valve Torque Motor (TM),
- the fuel shut-off TM,
- the overspeed TM,
- the servo pressure regulator,
- fuel metering valve,
- PRSOV,
- the spill valve,
- the dump valve,
- the overspeed valve,
- PRSOV position microswitches,
- a metering valve position Linear Variable Differential Transducer (LVDT) sensor.

The servo pressure regulator keeps the servo fuel pressure to the metering valve at a constant value more than LP return pressure. This is necessary for accurate control of the metering valve.

The metering valve controls the rate of Fuel Flow (FF) for all operating conditions. The metering valve is hydraulically actuated and controlled by the metering valve TM. Metering valve position feedback for the control loop is sent to both channels of the EEC by a position resolver.

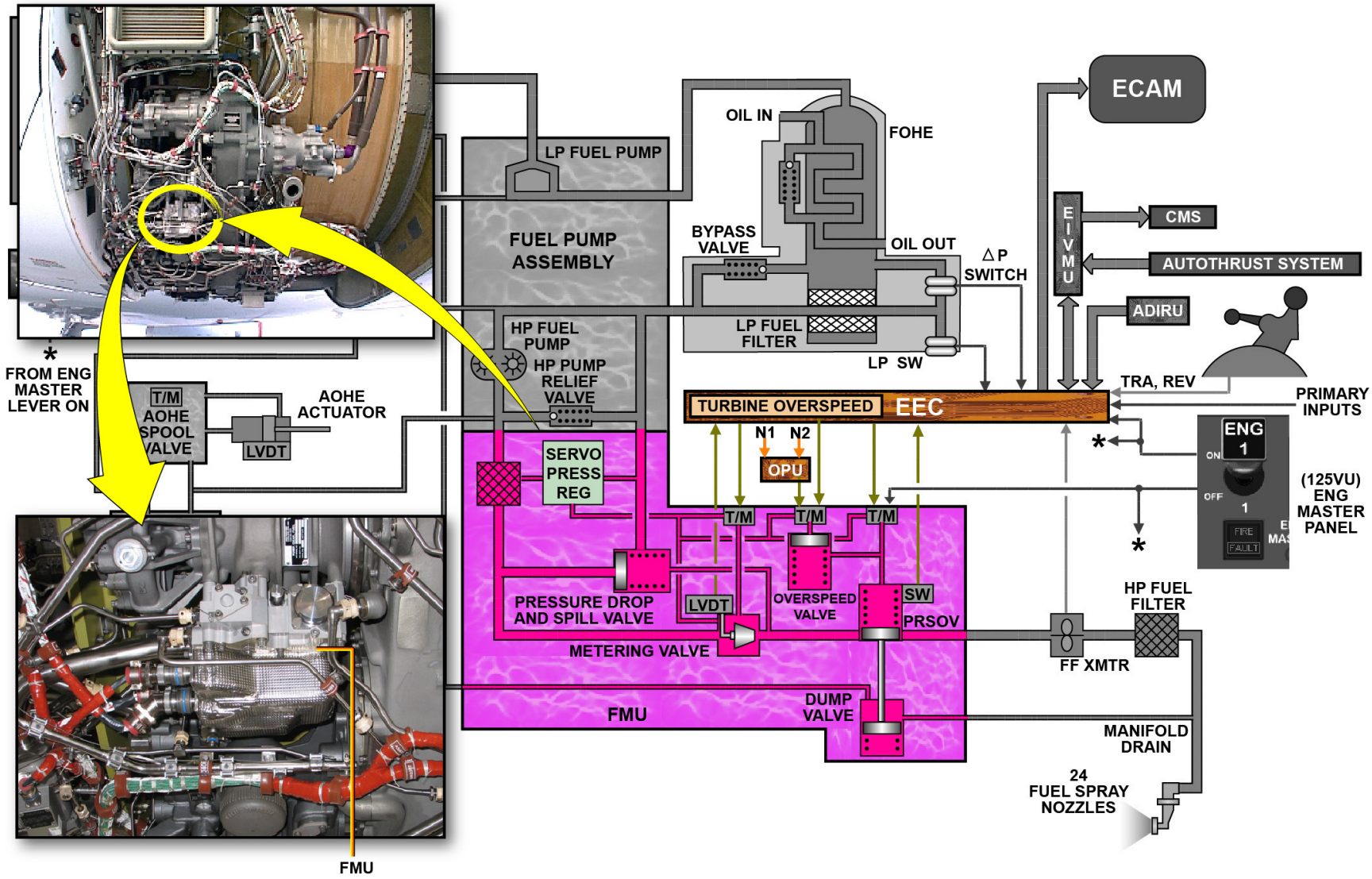
The pressure drop and spill valve keeps a constant pressure difference across the metering valve. So it 'spills' excess HP supply to the inlet of the HP fuel pump. PRSOV is downstream of the metering valve.

The PRSOV is downstream of the metering valve. It keeps the metered fuel at a suitable pressure for operation, stops the fuel flow for engine shutdown and operates the dump valve.
The PRSOV is opened by fuel pressure from the metering valve when the shut-off TM is de-energized. The ENGINE MASTER switch controls the shut-off TM. The shut-off TM is energized when the Master Switch is selected OFF. In case of automatic start abort on the ground, the EEC may also energize the shut-off TM.

The dump valve lets most of the fuel in the fuel manifold drain into the drain collector tank at engine shutdown.

It is closed during engine operation and opens as the PRSOV closes. The Overspeed Protection Unit (OPU) protects against N1 or N2 overspeed. If an overspeed condition is sensed, the OPU sends a signal to energize the overspeed TM. The overspeed valve then causes the PRSOV to close and shut down the engine.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - HIGH PRESSURE FUEL - HP PUMP & FUEL METERING UNIT - FMU

GCL13151 - G6RT1DU - FM70D3000000071

ENGINE FUEL SYSTEM D/O (3)

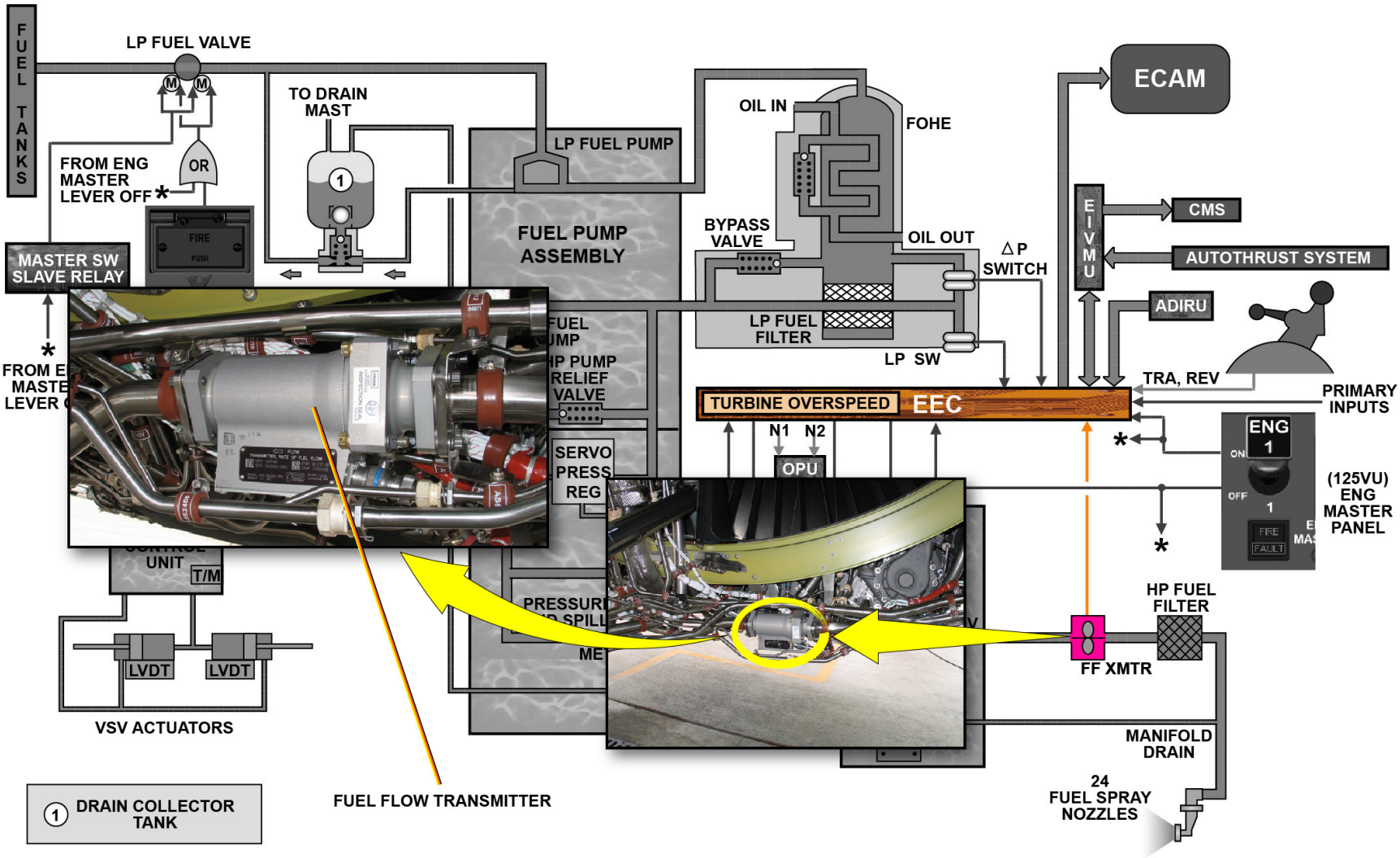
SYSTEM DESCRIPTION - METERED FUEL FLOW

After the FMU, the metered fuel flows through the fuel flow transmitter (FF XMTR) and the HP fuel is filtered before supplying the fuel manifold and 24 fuel spray nozzles.

FUEL FLOW TRANSMITTER

The fuel flow transmitter (FF XMTR) is installed on the rear LP compressor case at the bottom. It supplies electrical signals to the EEC, which are in proportion to the FF supplied to the combustion system.
The EEC uses these signals to compute the fuel flow and the fuel used. The FF is shown on the EWD and the fuel used on the SD ENGINE and CRUISE pages.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - METERED FUEL FLOW - FUEL FLOW TRANSMITTER

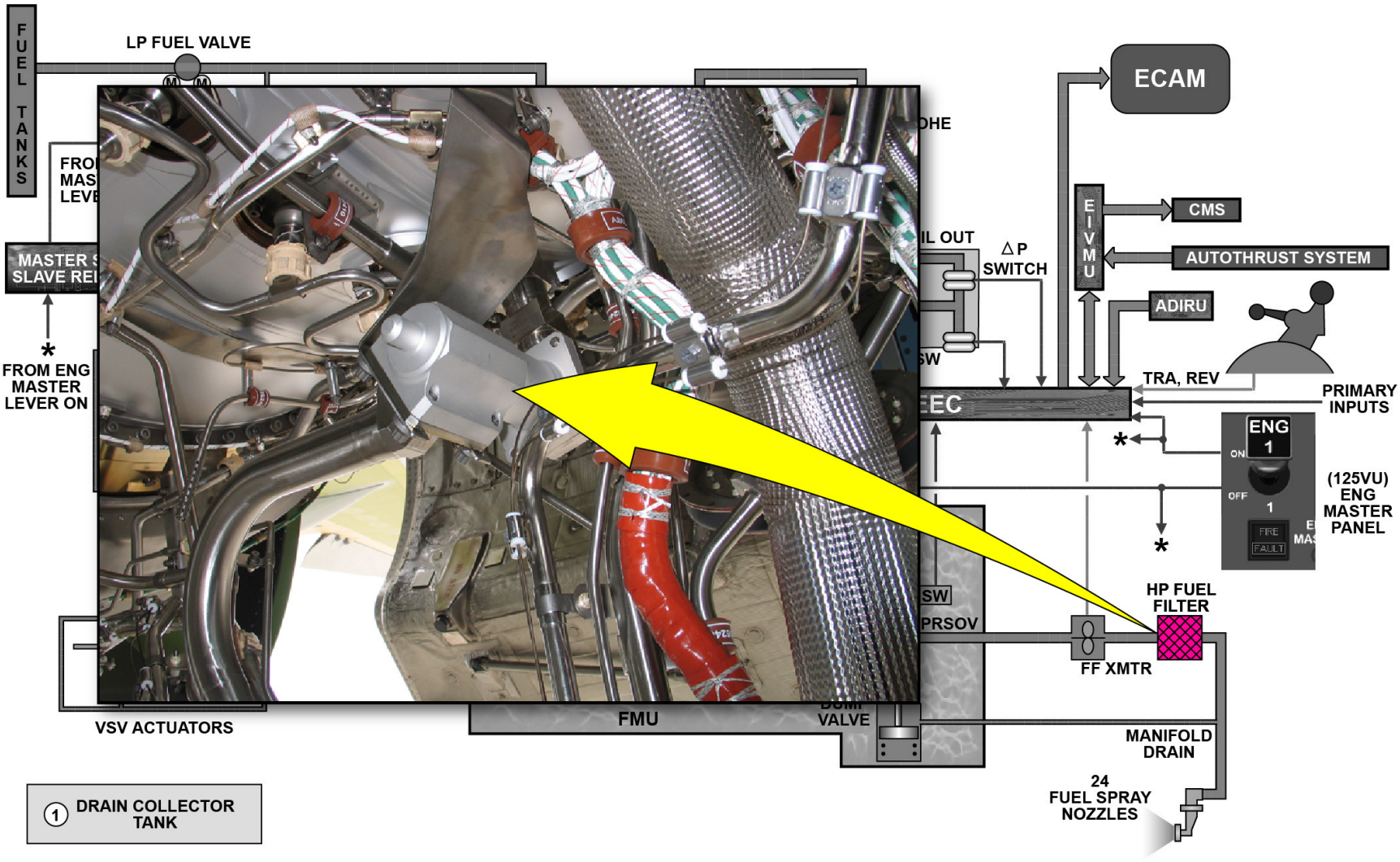
ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - METERED FUEL FLOW (continued)

HP FUEL FILTER

The HP fuel filter element can be cleaned of contamination and, if serviceable, can be used again.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - METERED FUEL FLOW - HP FUEL FILTER

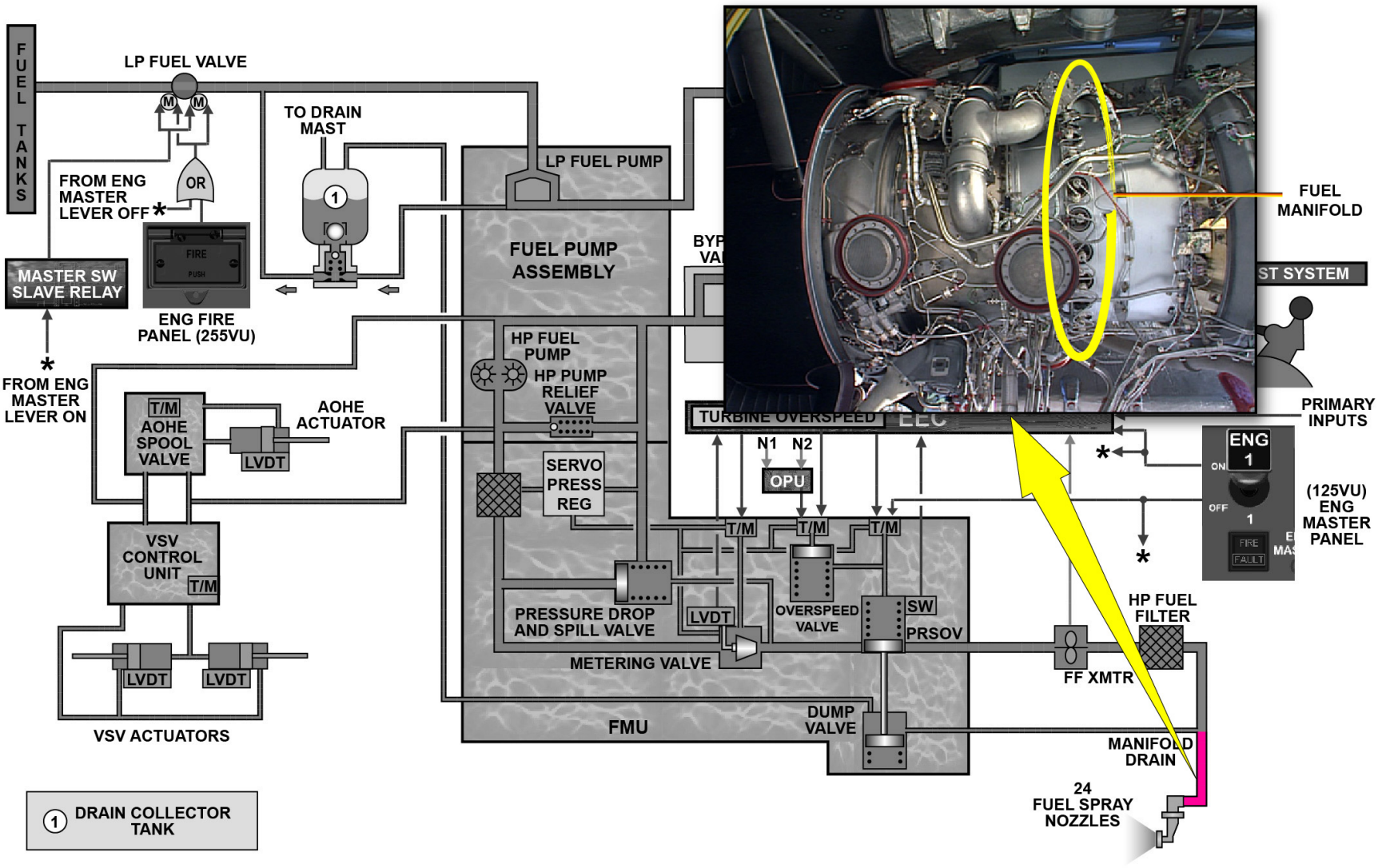
ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - METERED FUEL FLOW (continued)

FUEL MANIFOLD

The fuel manifold assembly equally supplies all 24 fuel spray nozzles. The manifold is split into 2 halves, each feeding 6 supply tubes. The 2 halves can be disconnected near the top and the bottom of the engine. Each supply tube is connected to an adjacent pair of fuel spray nozzles.

GCL13151 - G6RT1DU - FM70D3000000071



SYSTEM DESCRIPTION - METERED FUEL FLOW - FUEL MANIFOLD

GCL13151 - G6RT1DU - FM70D3000000071

ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - METERED FUEL FLOW (continued)

FUEL SPRAY NOZZLES

The 24 fuel spray nozzles are installed at equal distance around the combustion outer case. There are 12 LH and 12 RH nozzles grouped in adjacent pairs to suit the supply tubes.

The fuel flows into the inlet of the distributor weight assemblies. When there is sufficient fuel pressure at a nozzle, the weight in the assembly is pushed away from the inlet. Fuel then flows through the feed arm and rearward along a cavity in the nozzle head.

At the end of the cavity, there are small holes, which supply the fuel in a circular direction across the swirl chamber outlet.

Air at HP compressor outlet pressure (P30) flows into the swirl chamber in the nozzle head. The inner swirl vanes change the straight air flow into a circular air flow. This circular air flow is in the opposite direction to the circular fuel flow across the swirl chamber outlet, and helps to mix the fuel with the air satisfactorily.

Air at P30 pressure also flows along the outer surface of the nozzle head, through the outer swirl vanes and into the combustion chamber. The outer swirl vanes change this straight air flow into a circular air flow. This circular air flow then mixes with the fuel/air mixture at the outlet of the swirl chamber to make a satisfactory spray.

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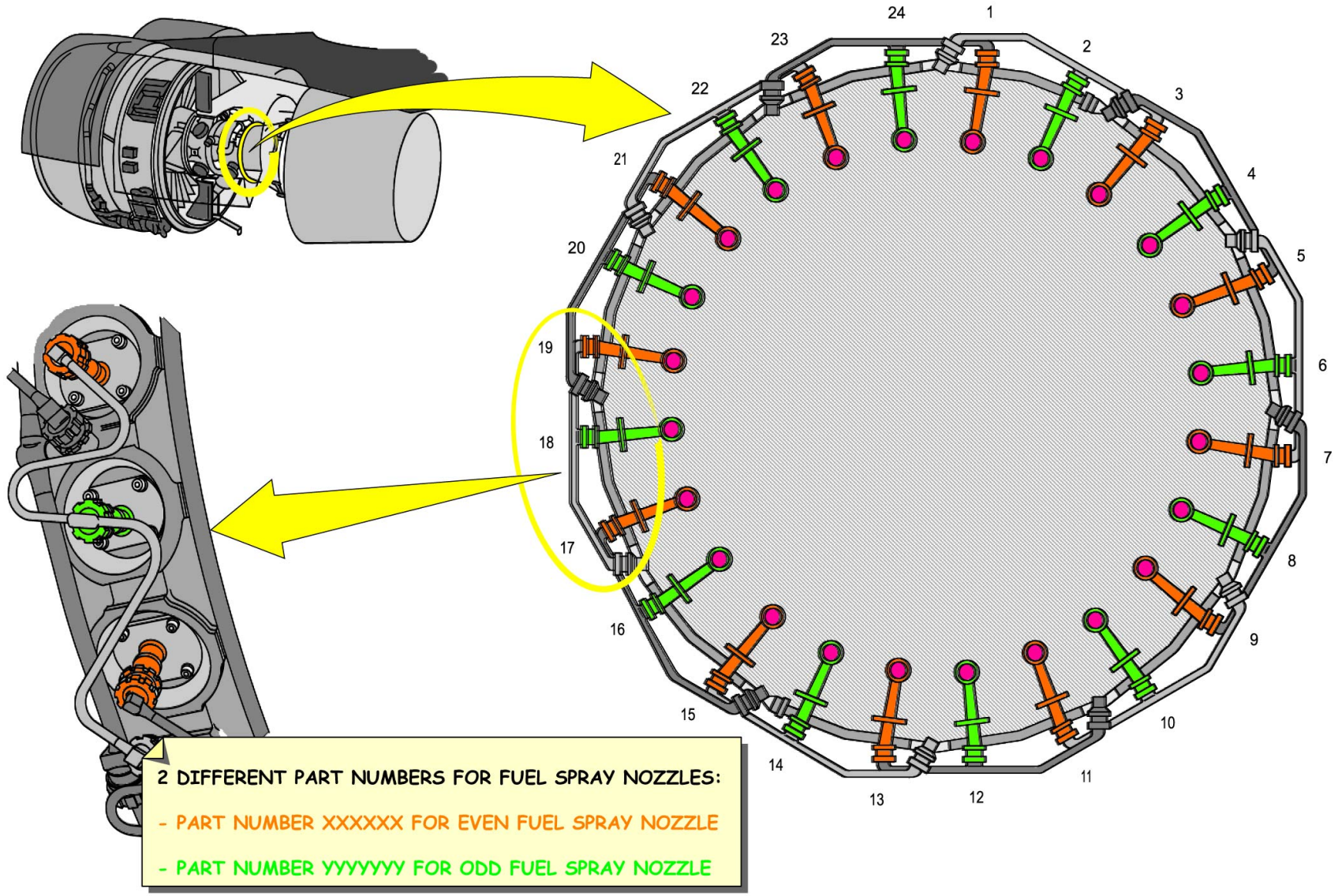
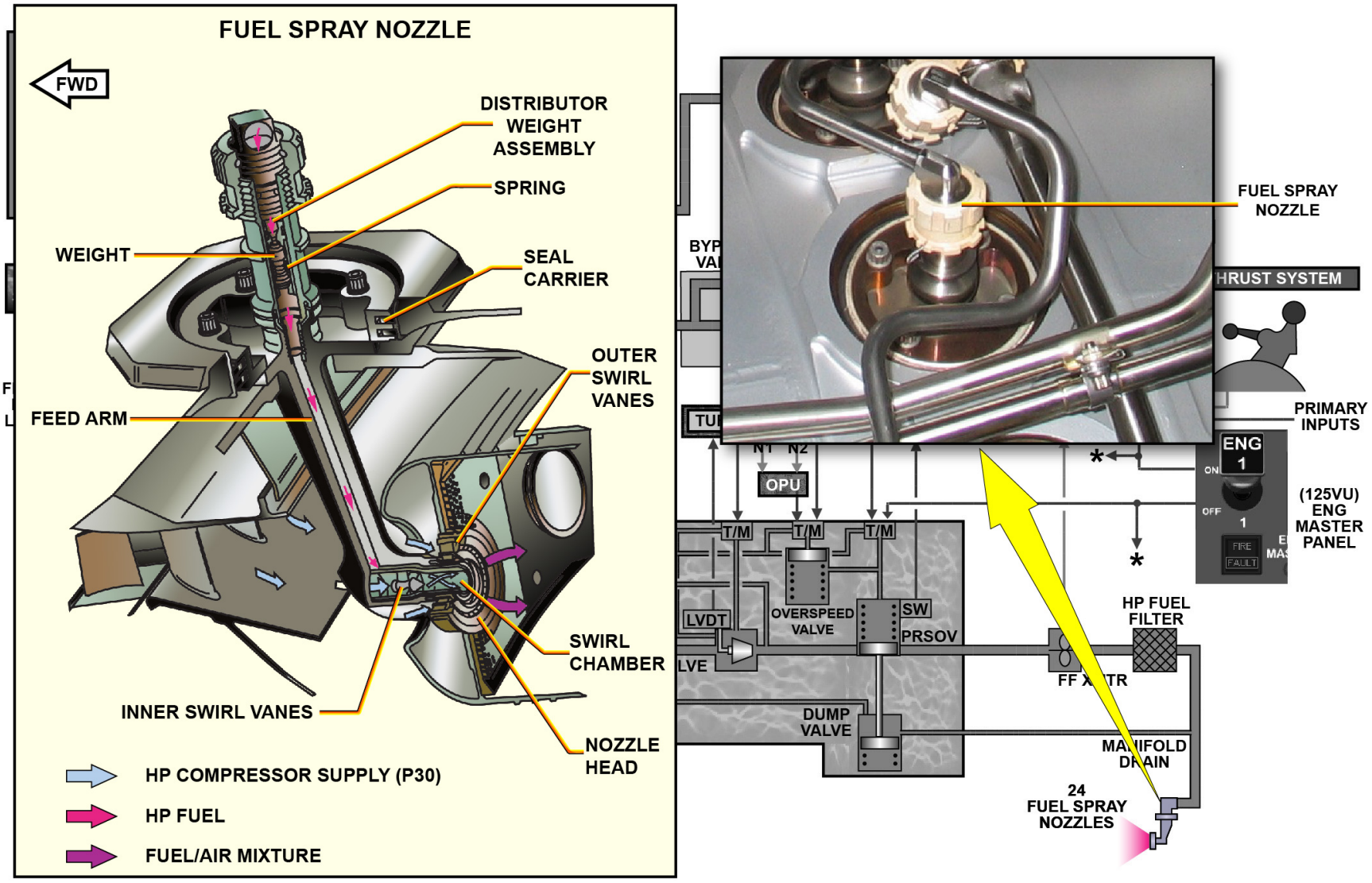


SYSTEM DESCRIPTION - METERED FUEL FLOW - FUEL SPRAY NOZZLES



SYSTEM DESCRIPTION - METERED FUEL FLOW - FUEL SPRAY NOZZLES

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ENGINE FUEL SYSTEM D/O (3)

SYSTEM DESCRIPTION - METERED FUEL FLOW (continued)

DRAIN TANK

When the engine is shut down or after a failure to start, the fuel is drained from the manifold to the drain tank via the dump valve in the FMU. If, after a number of failed starts, the drain tank becomes full, the excess fuel is discharged through the drain mast.
At engine start the LP fuel flows through the drain tank ejector pump, this causes a suction, which opens the non-return valve and drains the fuel from the drain tank. It then becomes part of the supply to the LP pump inlet.

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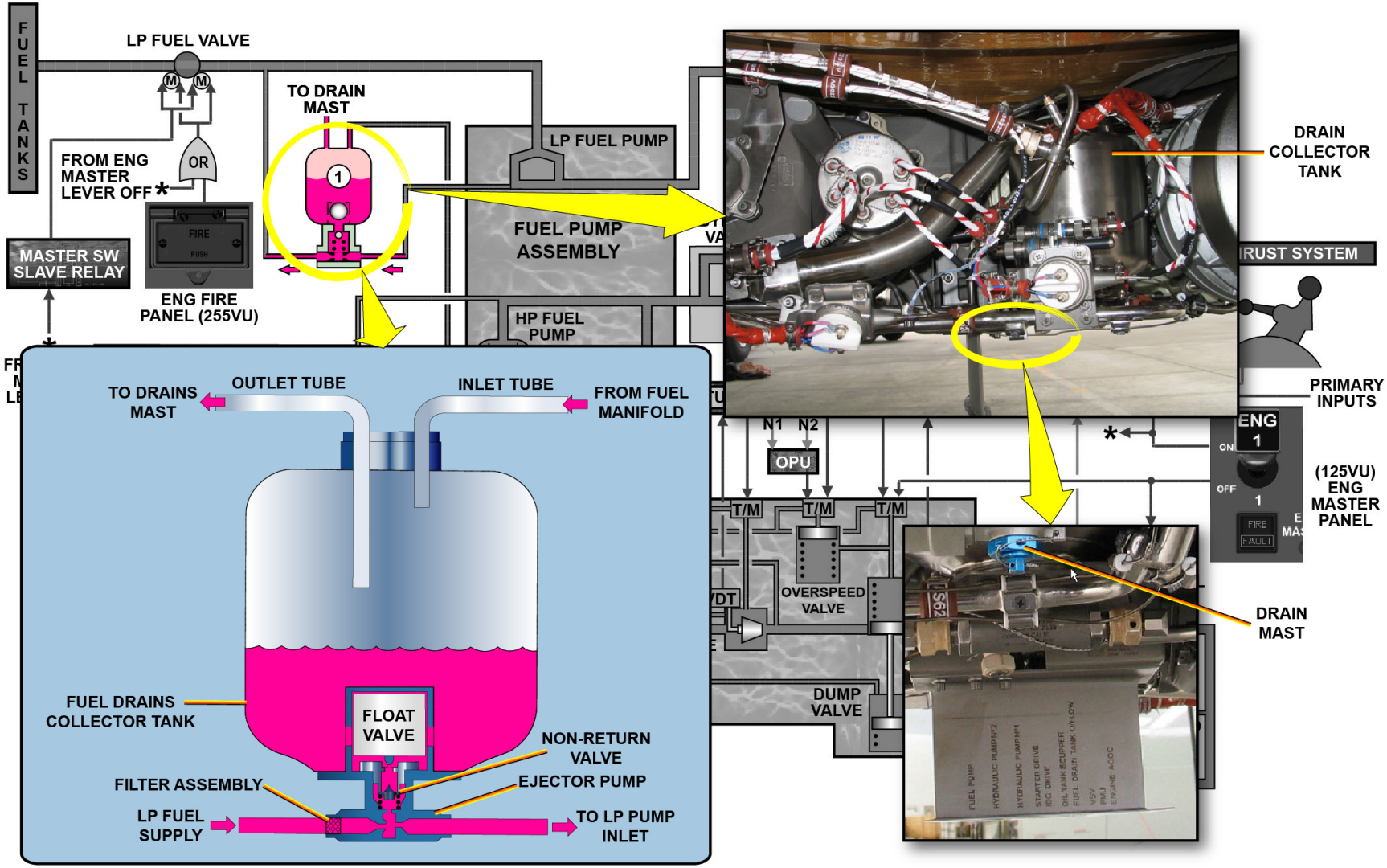


SYSTEM DESCRIPTION - METERED FUEL FLOW - DRAIN TANK

ENGINE FUEL SYSTEM D/O (3)

GENERAL OPERATION

STARTING AND THRUST CONTROL

During engine start, when the ENGine MASTER switch is selected ON, the LP fuel valve is commanded open via the master switch slave relay. At this time, the springs and shut-off valve servo pressure keep the PRSOV closed.

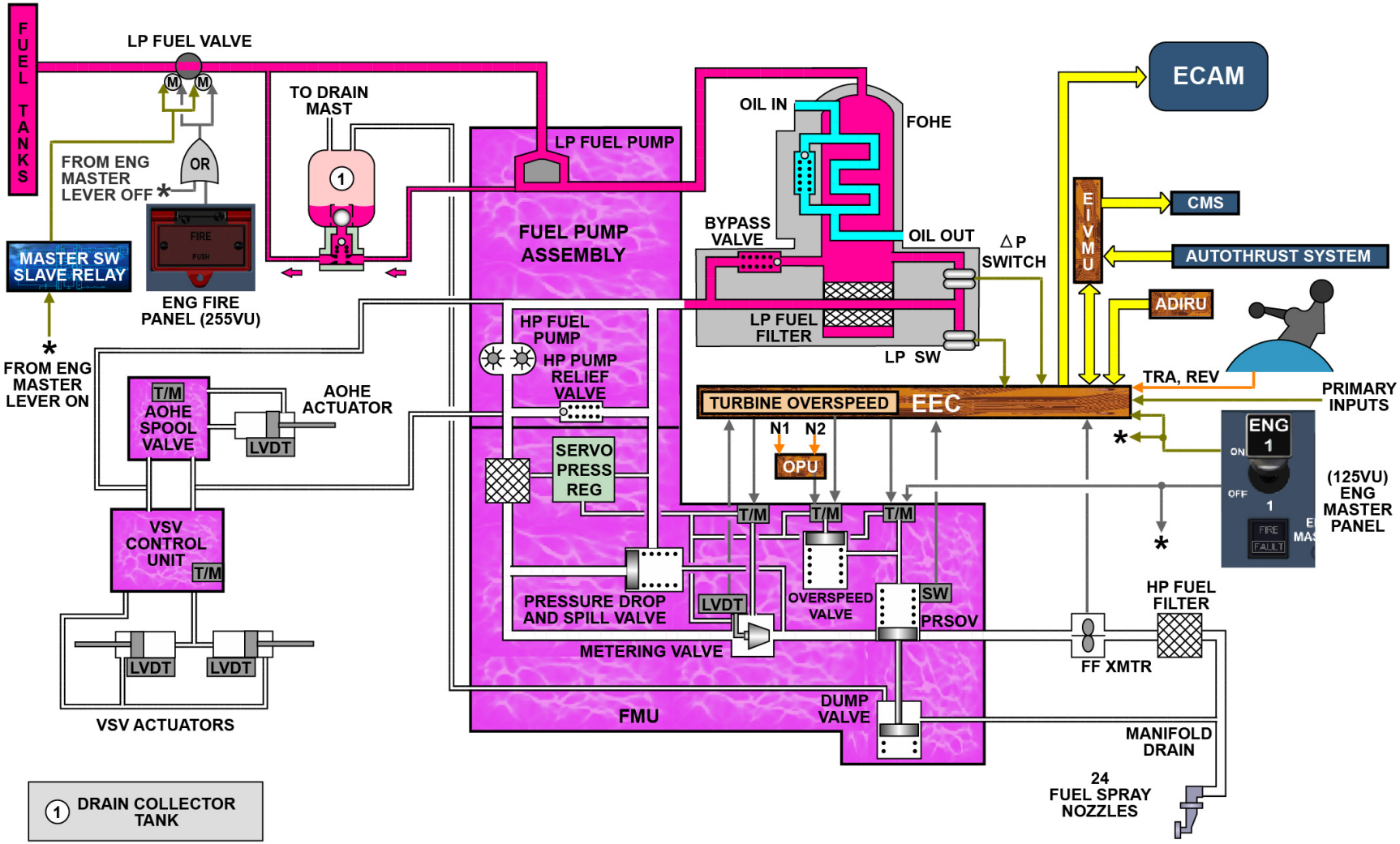
The EEC manages the engine thrust by controlling the metering valve position via the electrical current supplied to the metering valve TM. The metering valve position is a function of the throttle control lever position or Throttle Resolver Angle (TRA) in manual thrust or a thrust command from the Autothrust System in automatic thrust control.

The thrust command signal is routed through the Engine Interface and Vibration Monitoring Unit (EIVMU).

As the metering valve opens, the metered fuel pressure increases and becomes greater than the PRSOV spring tension and opens the valve. Metered fuel is then supplied to the fuel spray nozzles through the fuel flow transmitter and the HP fuel filter.

Two microswitches give the position of the PRSOV to the EEC.

GCL13151 - G6RT1DU - FM70D3000000071



GENERAL OPERATION - STARTING AND THRUST CONTROL

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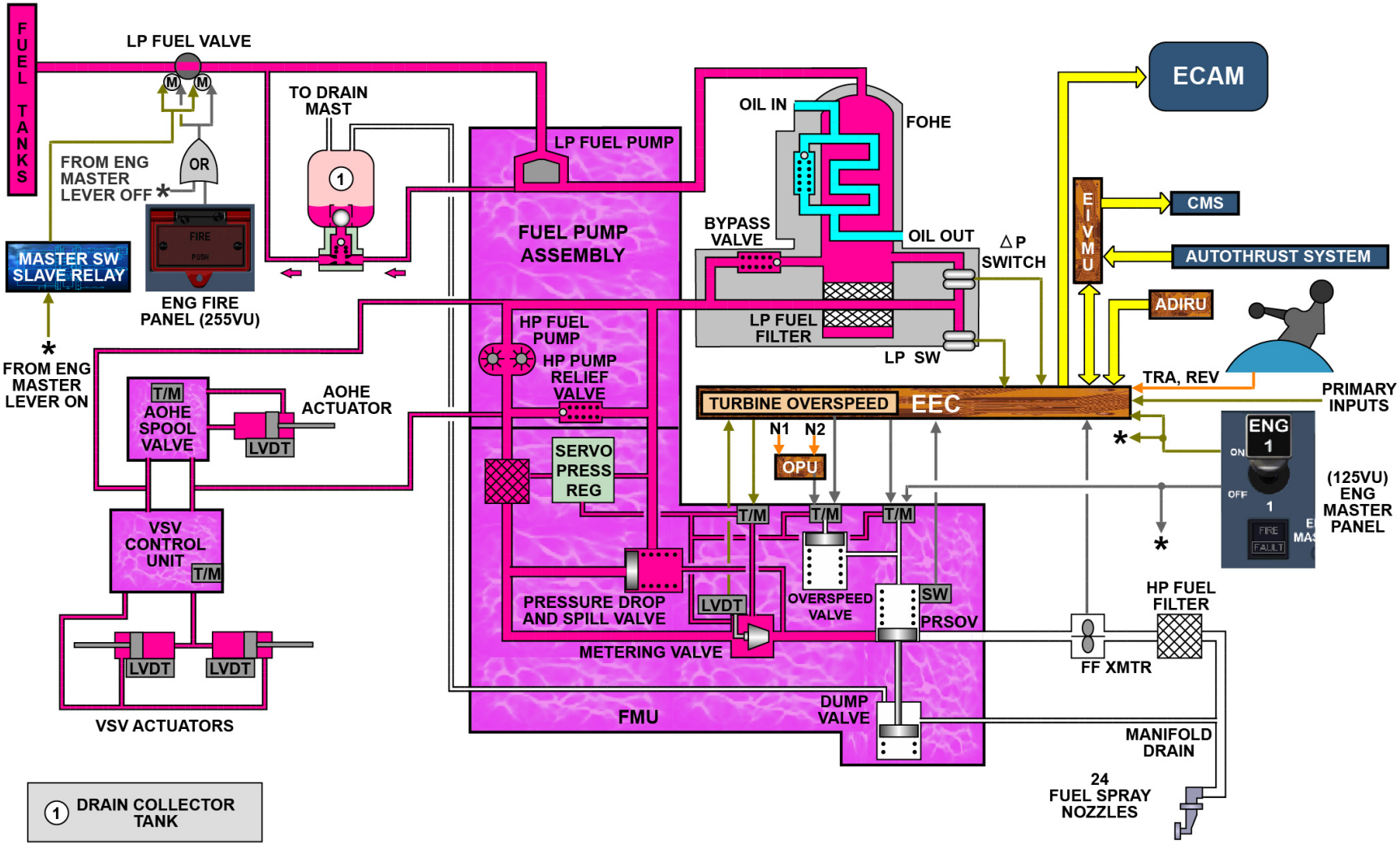

GENERAL OPERATION - STARTING AND THRUST CONTROL

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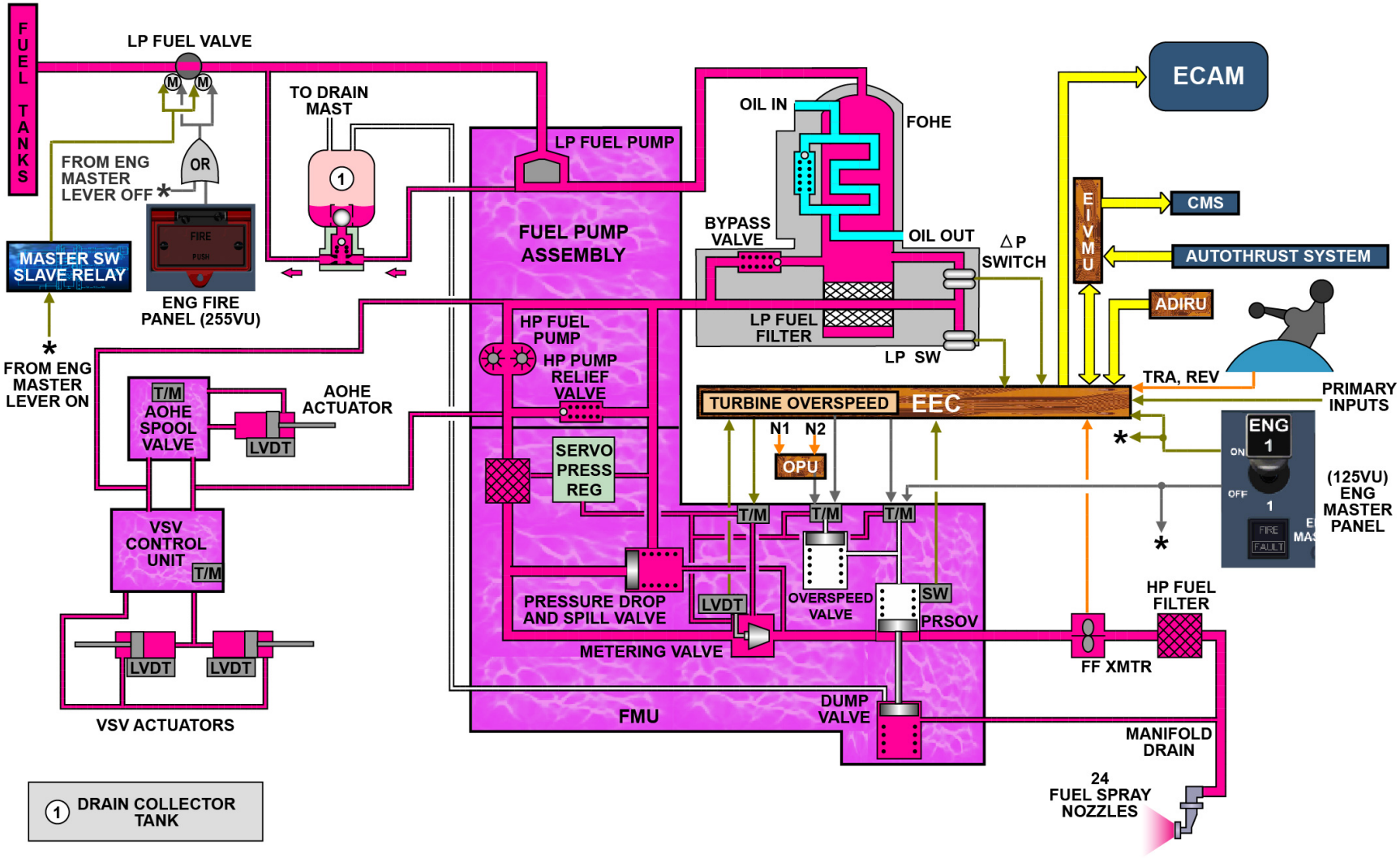

GENERAL OPERATION - STARTING AND THRUST CONTROL

GCL13151 - G6RT1DU - FM70D3000000071

ENGINE FUEL SYSTEM D/O (3)

GENERAL OPERATION (continued)

SHUTDOWN

During a normal engine shut down, when the ENGine MASTER switch is selected OFF, the fuel shut-off TM is directly controlled to close the PRSOV. This command overrides any EEC command to make sure that the operator always has the option to shut down the engine for any reason. The LP fuel valve also closes when the Master switch is selected OFF. The shut-off servo pressure helped by the spring force, hydraulically closes the PRSOV. When the PRSOV closes, the dump valve opens and the fuel is drained to the drain tank. The ENGine FIRE P/B also controls the LP fuel valve to the closed position in order to isolate the engine from the fuel tanks.
The EEC receives a closed position signal from the PRSOV microswitches.

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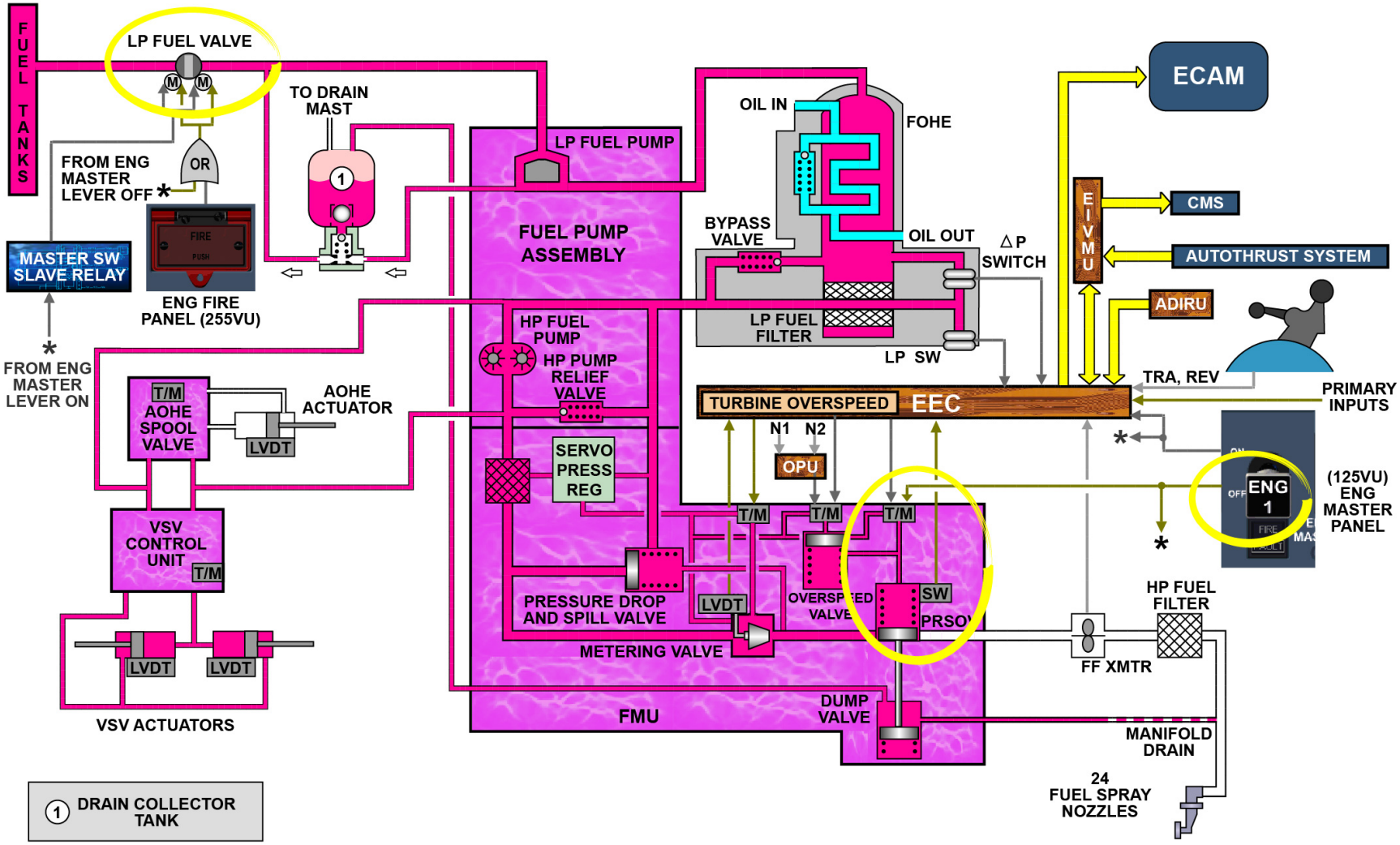

GENERAL OPERATION - SHUTDOWN

GCL13151 - G6RT1DU - FM70D3000000071

ENGINE FUEL SYSTEM D/O (3)

GENERAL OPERATION (continued)

MONITORING

Impending fuel filter clogging is detected by the fuel filter differential pressure switch (P), which sends a signal to the EEC. In the cockpit, an ECAM warning "ENG FUEL FILTER CLOG" is shown on the EWD and an amber "CLOG" indication appears close to the FUEL USED indication on the SD ENGINE page.
A fuel low-pressure switch monitors the fuel pressure downstream of the LP fuel filter. The switch detects low fuel pressure and sends a signal to the EEC that will trigger the linked class 2 fault message.

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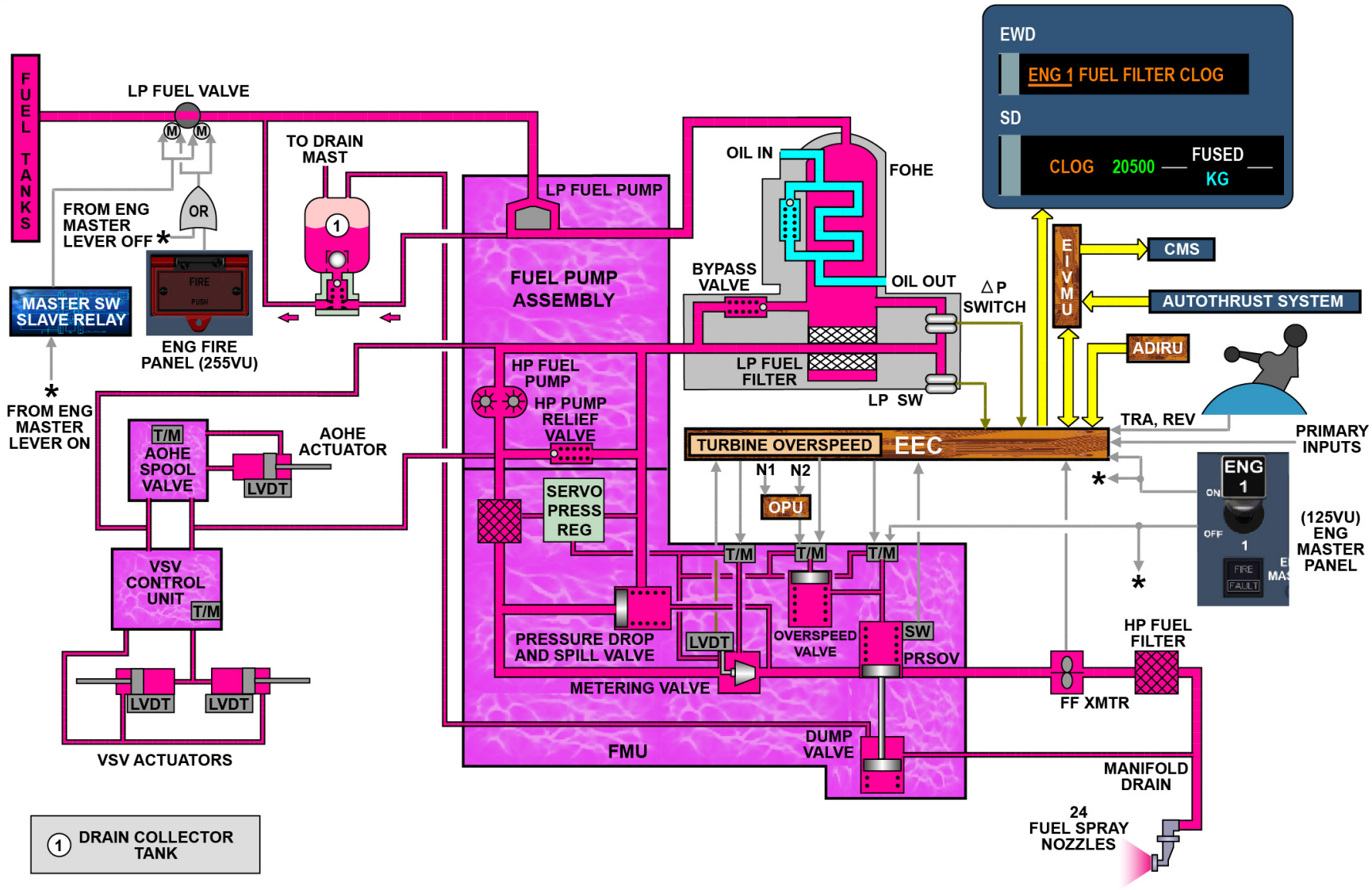

GENERAL OPERATION - MONITORING

GCL13151 - G6RT1DU - FM70D300000071

ENGINE LIMIT PROTECTION D/O (3)

GENERAL

Based on engine parameters, the Engine Electronic Controller (EEC) ensures limit protection for:
- N1, N2 and N3 shaft speeds.

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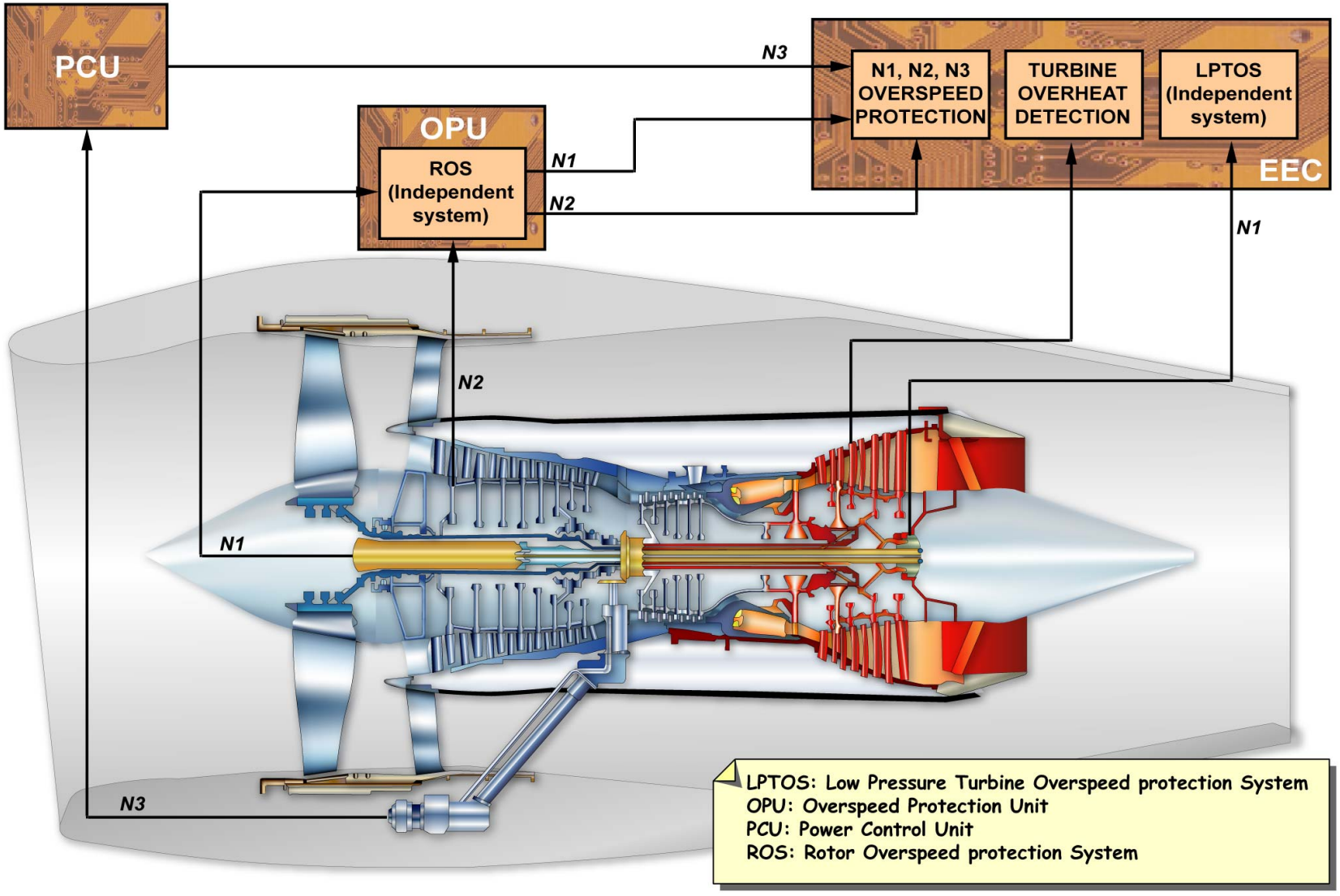
PCU
N3
N1, N2, N3 OVERSPEED PROTECTION
TURBINE OVERHEAT DETECTION
LPTOS (Independent system)
EEC
OPU
ROS (Independent system)
N1
N2
N1
N2
N1
N3
LPTOS: Low Pressure Turbine Overspeed protection System
OPU: Overspeed Protection Unit
PCU: Power Control Unit
ROS: Rotor Overspeed protection System

GENERAL

ENGINE LIMIT PROTECTION D/O (3)

OVERSPEED PROTECTION SYSTEM

If an overspeed occurs and the EEC cannot detect it, the Rotor Overspeed protection System (ROS) automatically stops the engine. The ROS is an independent system from the EEC.
In the unlikely event of a LP turbine shaft breakage, the LP Turbine Overspeed protection System (LPTOS) is designed to automatically shut down the engine. The LPTOS is an independent system to EEC, even if physically located in EEC (channel A part).
The IP turbine is protected against overspeed and overheat by monitoring of the turbine cooling air temperature.
The Overspeed Protection System (OPS) protects the ROS and LPTOS.
The ROS protection is done by the Overspeed Protection Unit (OPU), which also ensures the selection of the corresponding compressor speed probes.
The LPTOS protection is done by a dedicated circuit board located in the EEC channel A part.

SPEED PROBE INSTALLATION

There are three measuring stations corresponding to the measurement of:
- the LP Compressor speed, or N1C,
- the IP Compressor speed, or N2,
- the LP Turbine speed, or N1T.

The measuring stations dedicated to N1C and N2 are installed in the front bearing housing. The measuring station dedicated to N1T is installed in the tail bearing housing.
Each measuring station is composed of a phonic wheel and three inductive speed probes.
The LP compressor and IP compressor speed probes outputs (N1C and N2) are sent to the OPU.
The LP turbine speed probes outputs are sent to the independent LPTOS circuit board of the EEC.

COMPRESSOR SPEED PROBE SELECTION

The OPU has two channels:
- a N1 function channel which receives inputs from three N1C speed probes,
- a N2 function channel which receives inputs from three N2 speed probes.

Each OPU channel selects two valid signals out of the three signals received from N1C or N2 speed probes. The N1C and N2 speed signals are then sent to both EEC channels for N1 and N2 monitoring and indicating.
The third speed signal is only selected, as a spare signal, if a fault is detected with one of the speed probe signals initially selected.
The N1C signals are also used by the LPTOS circuit board of the EEC for turbine overspeed detection.

ROTOR OVERSPEED DETECTION

In each OPU channel, the N1C or N2 selected signals are used for overspeed detection logics.
Each OPU channel changes its N1C or N2 analog signal inputs to digital signals. These signals are then monitored by the overspeed detection logic circuit.
In case of N1 or N2 severe overspeed detection, the corresponding OPU channel sends an electrical signal to the Overspeed Valve Torque Motor (TM) in the Fuel Metering Unit (FMU). The Overspeed Valve then closes the Pressure Raising and Shut Off Valve (PRSOV) to cut off the fuel supply from the FMU and thus to shut down the engine, independently of the normal shutdown control.

LP TURBINE OVERSPEED DETECTION

The independent LPTOS circuit board is installed in EEC channel A part. This circuit board has two overspeed logic circuits for LP turbine overspeed detection.

GCL13151 - G6RT1DU - FM70DB00000071

The LPTOS circuit board receives the N1C signals from the OPU. One N1C signal is supplied to each logic circuit of the LPTOS.
Three N1T signals are sent to the LPTOS circuit board directly from the corresponding speed probes. Each logic circuit of the LPTOS is supplied with one N1T signal. The third signal is only selected, as a spare signal, if a fault is detected with one of the speed probe signals initially selected.
Each logic circuit continuously compares its LP turbine speed input with its LP compressor speed input.
If the two logic circuits detect a specified speed difference between the LP turbine and LP compressor (in a specified time limit), a LP shaft breakage is diagnosed. In that case, the system immediately sends an electrical signal to the Overspeed Valve TM in the FMU.
The Overspeed Valve then closes the PRSOV to cut off the fuel supply from the FMU and thus to shut down the engine, independently of the normal shutdown control.
If one logic circuit (A or B) becomes defective, the LPTOS circuits are disarmed to prevent any incorrect operation of the system.

OVERSPEED SYSTEM AUTO TEST

The EEC does an automatic test of the LPTOS protection during every ground engine start (before light up). Test signal is cancelled almost immediately in order not to impact the starting sequence.
The EEC receives PRSOV closure feedback from its two position switches.

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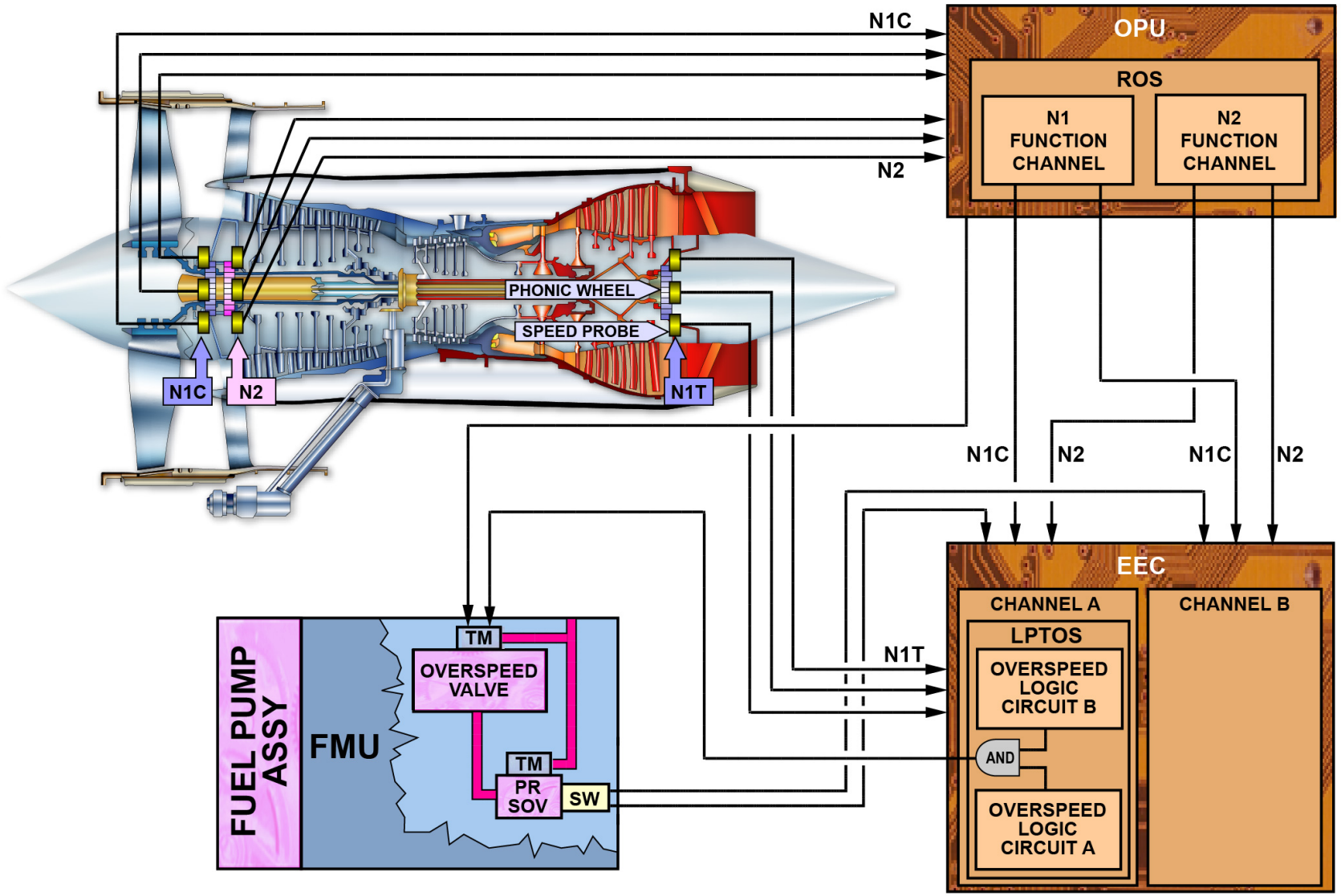

OVERSPEED PROTECTION SYSTEM - SPEED PROBE INSTALLATION ... OVERSPEED SYSTEM AUTO TEST

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ENGINE LIMIT PROTECTION D/O (3)

TURBINE OVERSPEED & OVERHEAT DETECTION SYSTEM

The turbine overspeed & overheat detection system measures the temperature of the IP turbine disk cooling air, at both sides of the turbine disk.
If the temperature at the front or the rear of the IP turbine rises above the specified limit, the EEC will reduce the engine thrust and trigger corresponding warning.

DESCRIPTION

The turbine overheat detection system includes 2 detector assemblies of the dual thermocouple type attached to the High Pressure (HP)/IP turbine case.
There is one detector assembly located at the front of the IP turbine disk and one at the rear.
The rear turbine overheat detector is installed through one of the LP stage 1 (LP1) nozzle guide vanes,
the front turbine overheat detector is installed through one of the IP turbine nozzle guide vanes.
Each detector assembly has two thermocouple elements: one sends a signal to channel A of the EEC, the other sends a signal to channel B. The voltage of each signal is proportional to the temperature sensed by its related thermocouple.

OPERATION

An overspeed and/or overheat condition is detected, if:
- both thermocouple elements in the same detector sense the overheat limit.
- one element senses an overheat limit and the other element in the same detector is faulty.

If the temperature of the IP turbine disk cooling air reaches a specified limit, first the EEC automatically limits the engine thrust up to 55% of the maximum available thrust, and triggers the "ENG1(2) THRUST LIMITED" level 2 warning.
If the temperature is still above the specified limit despite the power reduction, after five seconds the EEC will trigger the "EN1(2) TURBINE OVHT" level 3 warning, requesting to manually set the affected engine at idle power.
If the warning persists, the engine must be shut down.

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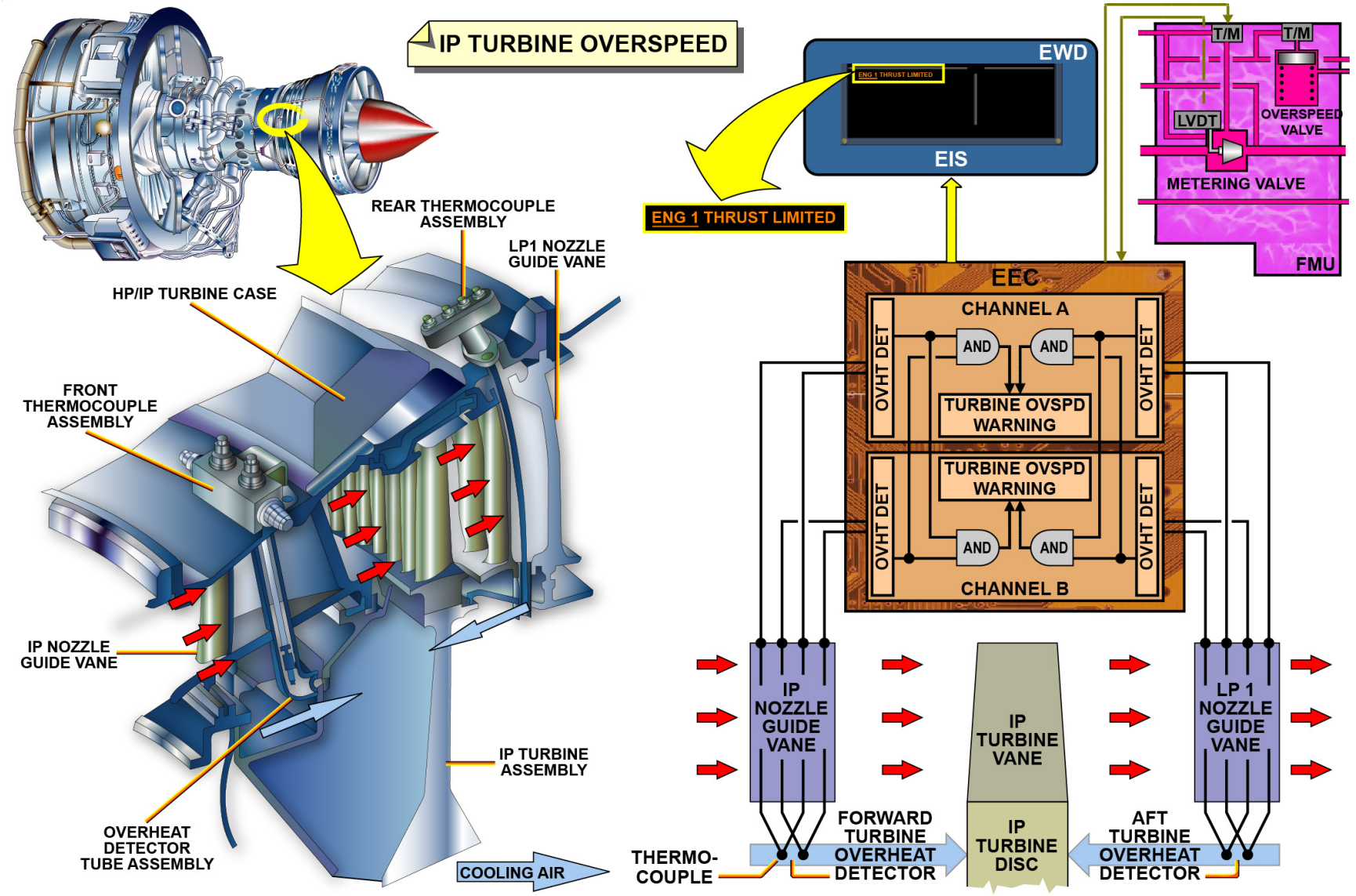

TURBINE OVERSPEED & OVERHEAT DETECTION SYSTEM - DESCRIPTION & OPERATION

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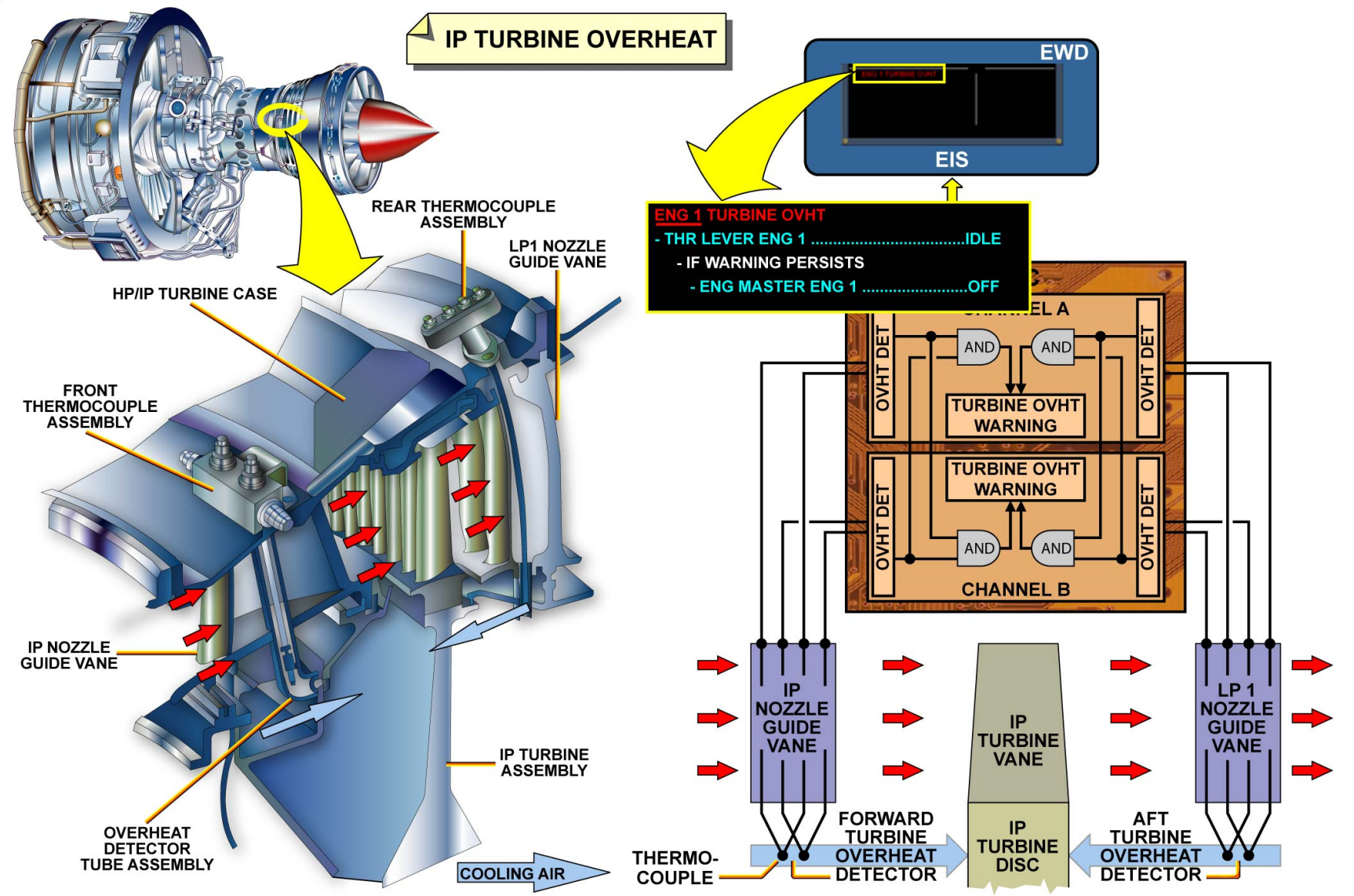

TURBINE OVERSPEED & OVERHEAT DETECTION SYSTEM - DESCRIPTION & OPERATION

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FADEC PRINCIPLE (3)

GENERAL

The Full Authority Digital Engine Control (FADEC) controls and monitors the engine and engine subsystems. It includes the Engine Electronic Controller (EEC), which is a dual channel computer, a Power Control Unit (PCU), an Overspeed Protection Unit (OPU) and a set of peripherals (control components, sensors) directly connected to it. The EEC, PCU and OPU are installed into a ventilated electronic-unit-protection box located on the fan case LH side. The EEC controls the engine thrust based on manual or automatic thrust demands and uses information from A/C systems, some centralized by an interface computer called the Engine Interface and Vibration Monitoring Unit (EIVMU), to optimize engine operation.

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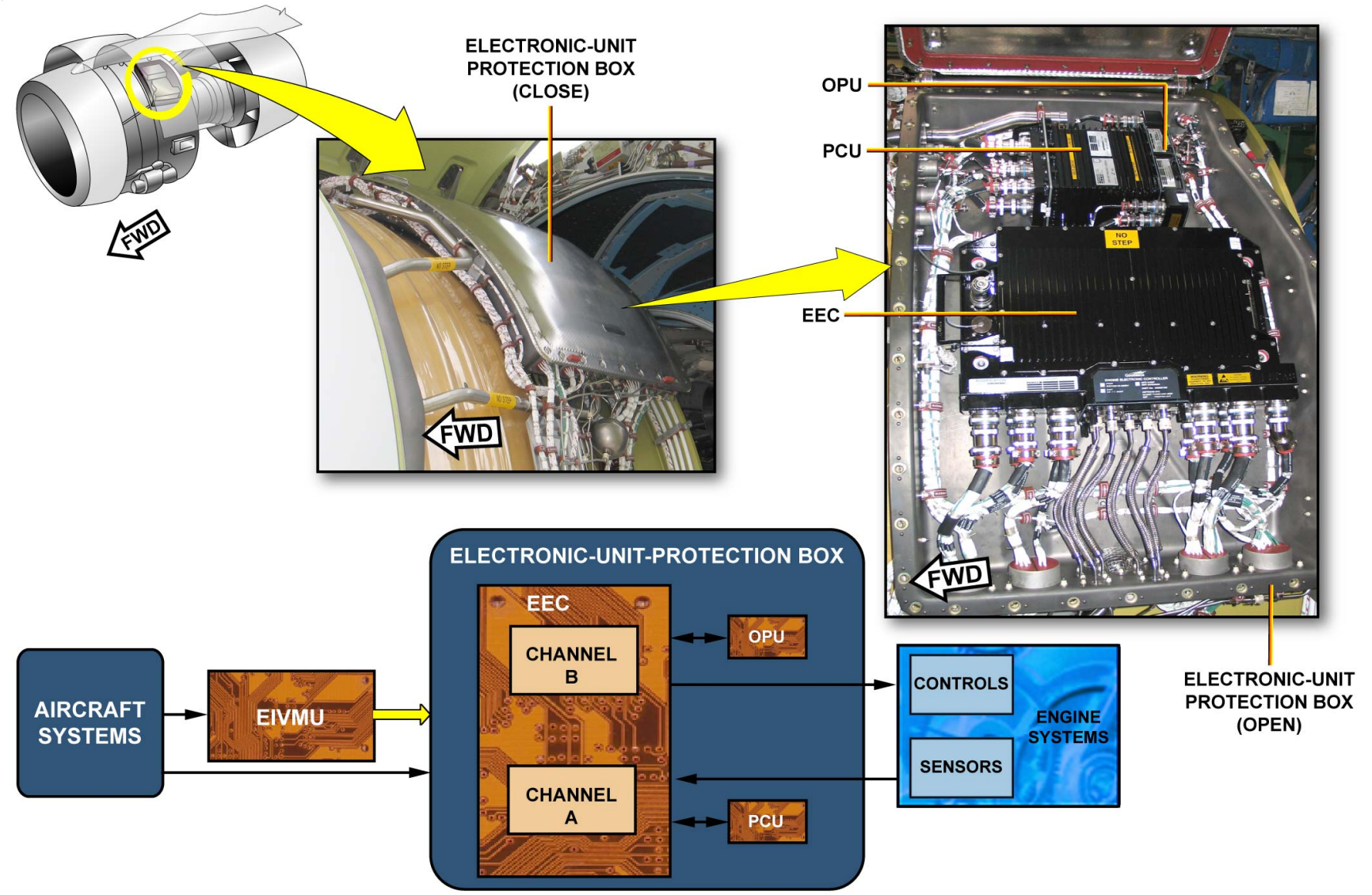
ELECTRONIC-UNIT
PROTECTION BOX
(CLOSE)
FWD
FWD
OPU
PCU
EEC
FWD
ELECTRONIC-UNIT-PROTECTION BOX
EEC
CHANNEL
B
CHANNEL
A
OPU
PCU
AIRCRAFT
SYSTEMS
EIVMU
CONTROLS
SENSORS
ENGINE
SYSTEMS
ELECTRONIC-UNIT
PROTECTION BOX
(OPEN)

GENERAL

FADEC PRINCIPLE (3)

FADEC DESIGN - ARCHITECTURE

The EEC is a digital unit made of two independent and similar channels of operation. The two channels are identified as channel A and channel B. Each channel communicates with the other one. All the hardware is mounted in the same housing.
Each channel receives inputs from the aircraft and from engine subsystem sensors, probes and switches. The signals from these devices are known as feedback signals. They are generally duplicated for channel A and B and "close the loop" on the EEC control functions. Each EEC channel is able to control engine subsystem torque motors and solenoids. Each channel also sends outputs to the aircraft.

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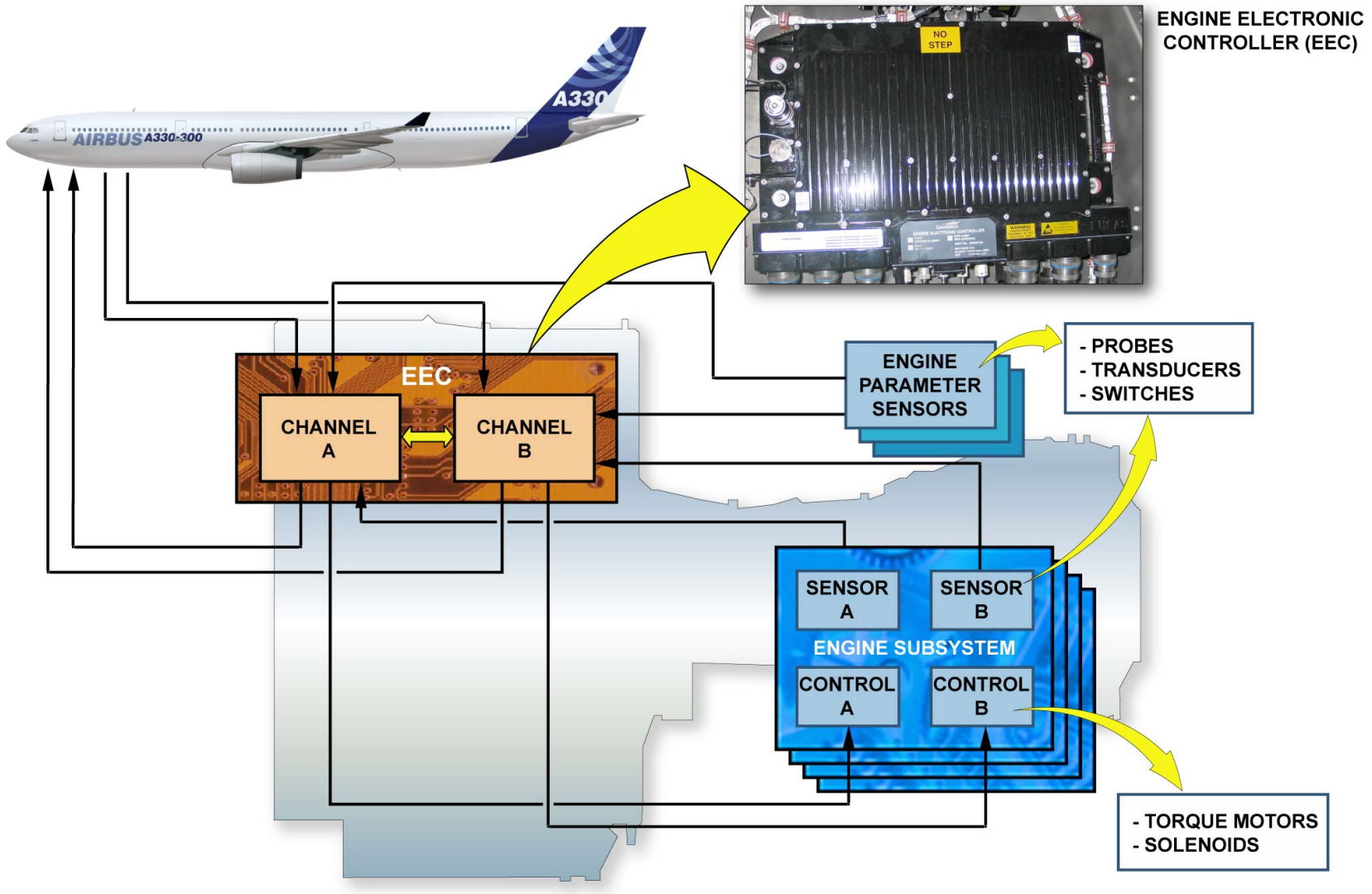

FADEC DESIGN - ARCHITECTURE

FADEC PRINCIPLE (3)

FADEC DESIGN - PROCESS

Most FADEC operations are based on the same principle: as a response to a demand from the aircraft or from the EEC internal schedules. Taking into account input parameters from the aircraft and the engine parameter sensors, the EEC generates a command signal sent to an engine subsystem. The EEC makes sure that its command has been followed by monitoring the feedback from the engine subsystem sensors. The EEC also sends data to the aircraft.
One channel controls (Active) while the other channel monitors (Standby). In case of an input failure, the control channel can access the inputs of the monitor channel through the inter-channel bus. This design keeps the active channel serviceable as long as possible.
In case of failure of a control channel circuit, the control is given to the standby channel. Normally the EEC changes over the control between channel A and channel B at each power up.

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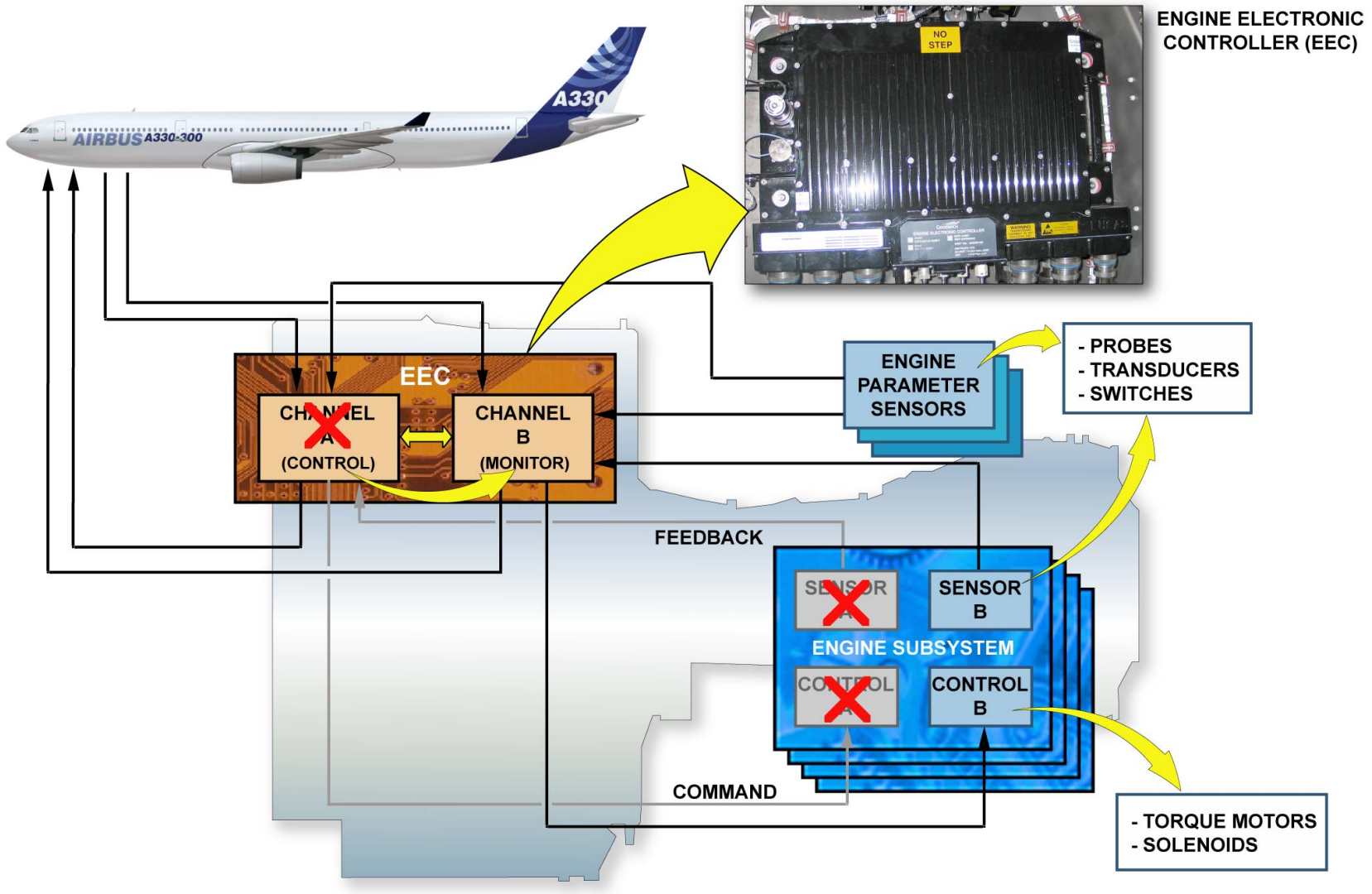

FADEC DESIGN - PROCESS

FADEC PRINCIPLE (3)

FADEC SUBSYSTEMS

The FADEC incorporates three main subsystems:
- engine control,
- overspeed protection,
- power supply.

NOTE: The subsystems are physically independent.

ENGINE CONTROL

The EEC controls and monitors various engine systems.
The most important control function of the EEC is to control engine thrust. Based on manual or automatic thrust demand, the EEC controls fuel flow through the metering valve in the Fuel Metering Unit (FMU).
The EEC controls the engine during the start sequence. The active channel controls the starter control valve and the PCU. The PCU controls the power supply for ignition. The EEC controls the airflow through the IP and HP compressors by means of the Variable Stator Vanes (VSVs) and the compressor handling bleed valves, in order to avoid surge and stall conditions.
The EEC controls the Turbine Impingement Cooling (TIC) system, which is used to cool the turbine case and optimize the clearance between the turbine blade tips and the case to improve the turbine efficiency. The EEC keeps the oil temperature within limits by controlling the air modulating valve of the Air Oil Heat Exchanger (AOHE).
The EEC controls the thrust reverser system operation through the use of the Isolation Control Unit (ICU) and the Direction Control Unit (DCU).
The High Pressure Valve (HPV), supplying the aircraft pneumatic system, is electrically controlled to the closed position by the EEC following certain engine operating conditions.

Several types of feedback components, such as sensors, switches, thermocouples, etc. are used by the EEC to monitor engine operation and to provide indications in the cockpit.

OVERSPEED PROTECTION

The OPU is designed to initiate an immediate engine shut down in case of Rotor OverSpeed (ROS) and/or Low Pressure Turbine OverSpeed (LP TOS) detection.
The OPU monitors the N1 and N2 rotor speed. If either speed exceeds the ROS limit, the OPU cuts off the fuel supply through the FMU.
The LP TOS protection is the function of an independent dedicated circuit board, installed in the EEC channel A. It compares the LP compressor speed with the LP turbine speed. In the unlikely event of an LP shaft breakage, the speed difference between the LP compressor and LP turbine is detected by the LP TOS protection circuit which cuts off the fuel supply through the FMU.

POWER SUPPLY

The electrical power supply to the EEC is controlled by the dual channel PCU. Each PCU channel independently supplies one EEC channel.
When the engine is running, a dedicated alternator installed on and driven by the external gearbox, supplies electrical power to the EEC through the PCU. The dedicated alternator also supplies the OPU. However, for ground maintenance, engine starting or in case of loss of dedicated alternator power, an alternate stand-by power source is supplied to the EEC from the aircraft 115 VAC network.

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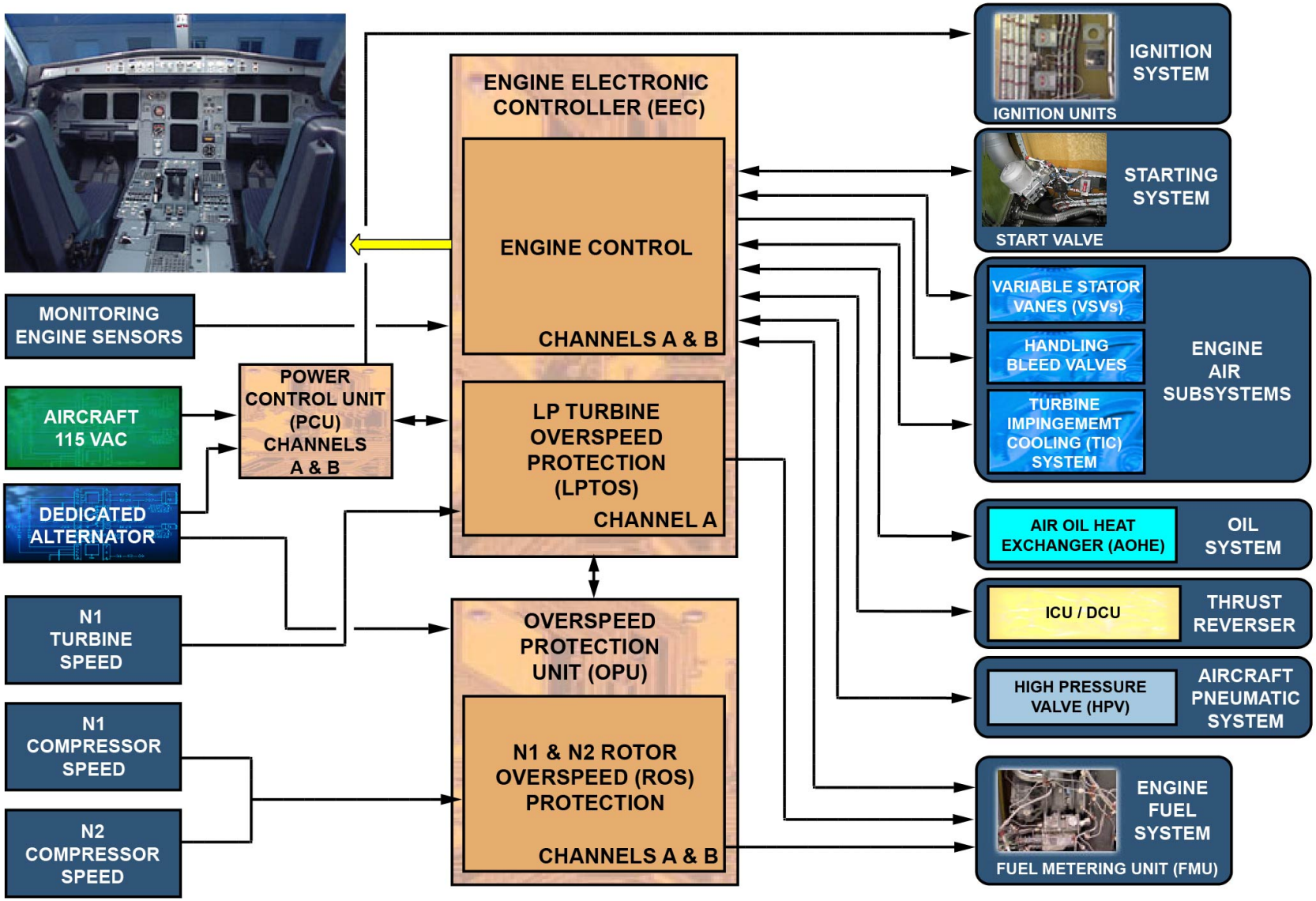

FADEC SUBSYSTEMS - ENGINE CONTROL ... POWER SUPPLY

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FADEC D/O (3)

FADEC OPERATION

The EEC is the primary component of the FADEC system. As such, the EEC is the interface between the aircraft and the engine. Aircraft computers and systems exchange data (control and monitoring signals) with both EEC channels. During engine operation, both channels exchange control and monitoring signals with the FMU and engine sub-systems. This module will detail the various EEC inputs and outputs on both the aircraft and engine sides.

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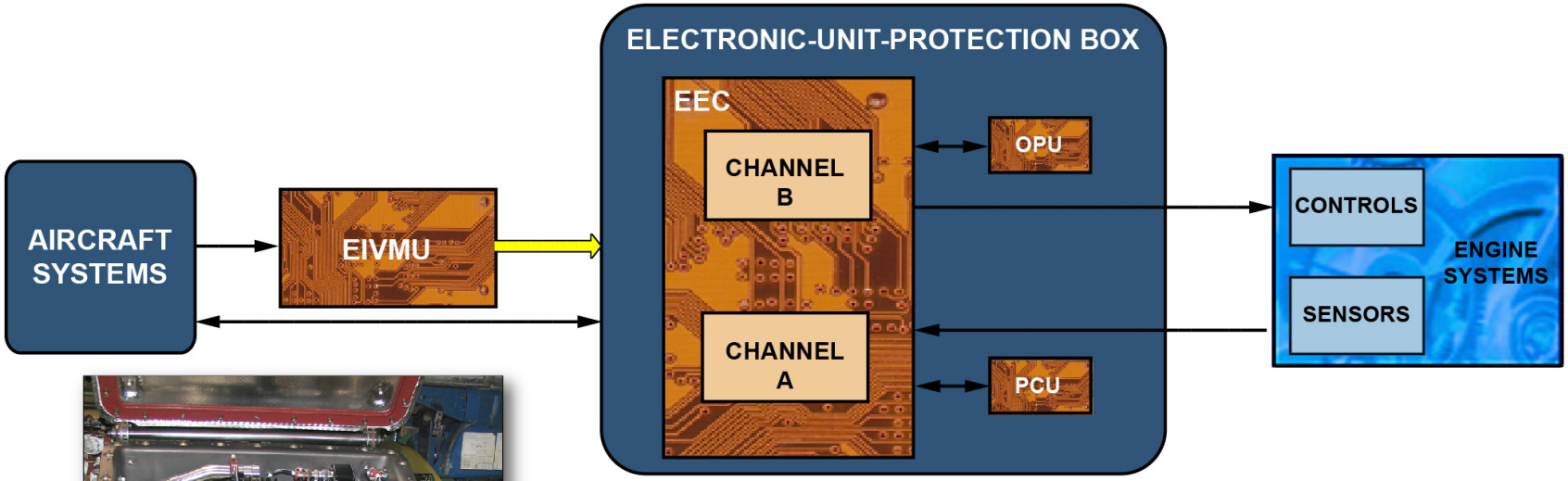

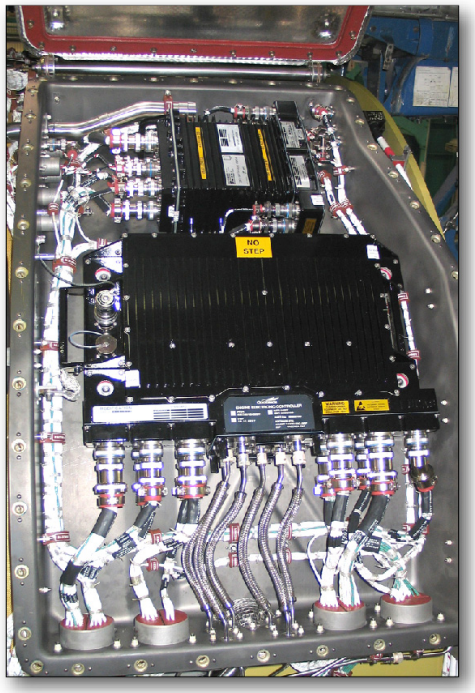

ELECTRONIC UNIT PROTECTION BOX

FADEC OPERATION

FADEC D/O (3)

EEC - ENGINE INTERFACE

The EEC controls the engine thrust and several engine sub-systems for normal operation and for engine efficiency. Only one channel of the EEC is in control but either channel can control all the systems. Similarly, all of the feedback signals for sub-system control and monitoring are dual signals sent to both EEC channels.

FUEL SYSTEM

The EEC controls three Fuel Metering Unit (FMU) torque motors. These torque motors (TM) operate three internal FMU servo-valves:
- a fuel metering valve, which controls the rate of fuel flow delivered to the combustion chamber,
- a Pressure Raising and Shut-Off Valve (PRSOV) which starts and stops the fuel flow,
- an overspeed valve which closes the PRSOV, in case of an overspeed condition, to shut down the engine.

Both EEC channels receive position feedback:
- two resolvers monitor the metering valve position,
- two microswitches monitor the PRSOV position.

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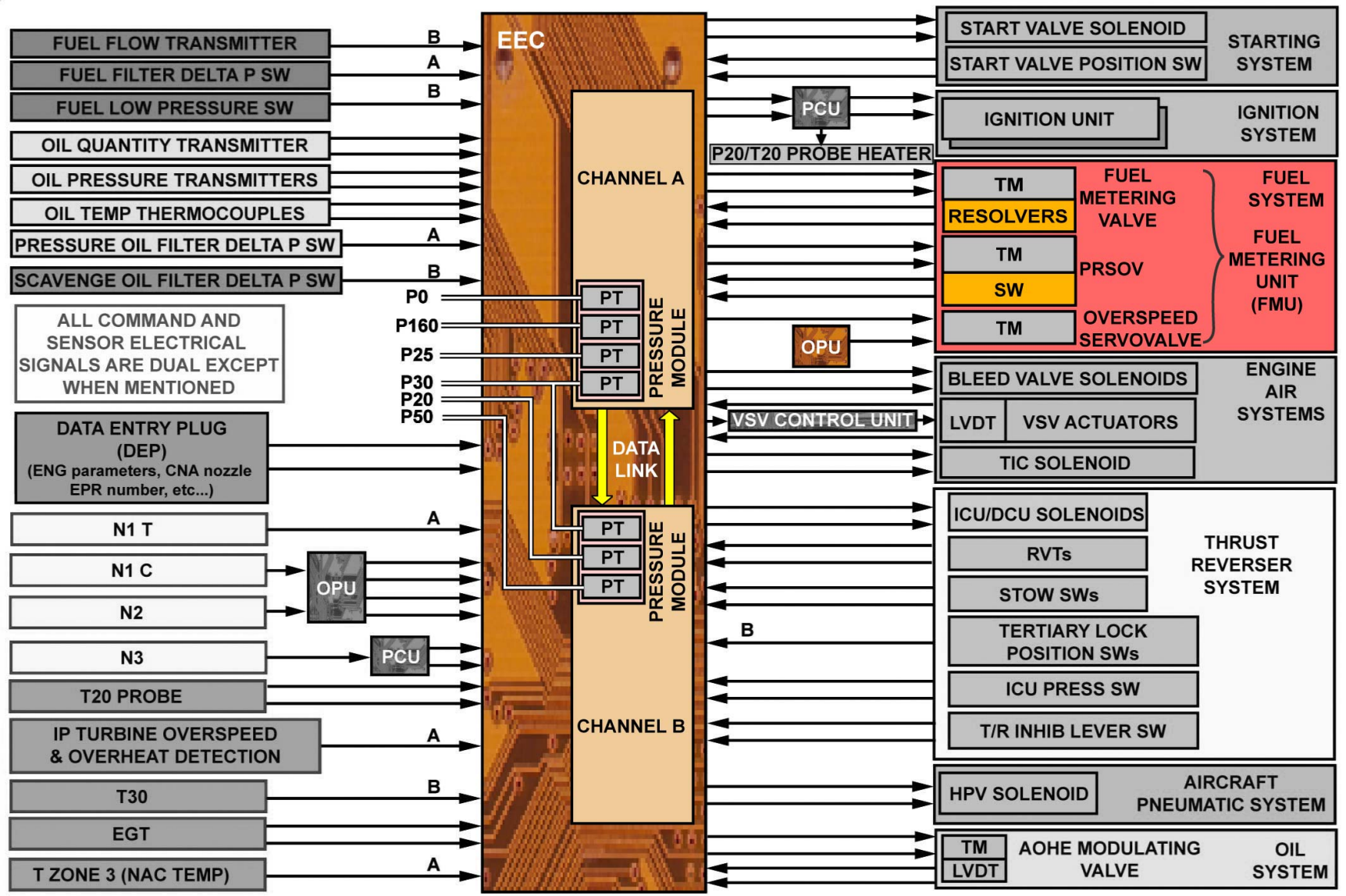

EEC - ENGINE INTERFACE - FUEL SYSTEM

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

ENGINE AIR SYSTEM

Compressor bleed valves are located around the compressor. The valves are used to unload the compressors during start and transient operations to prevent surges and stalls. The EEC controls the operation of four IP bleed valves, and three HP bleed valves through the bleed valve controller. The controller is supplied with HP3 air (high pressure compressor stage 3) and contains the IP and HP bleed valve solenoids, When a solenoid is energized by the EEC channel A or B, HP3 air is supplied to the related bleed valve.

Variable inlet guide vanes and the first 2 stages of stator vanes adjust the airflow through the IP compressor. The EEC controls the angular position of the variable vanes through the VSV control unit. A torque motor controlled servo-valve in the controller supplies high-pressured fuel to the VIGV/VSV actuators. The EEC receives feedback from LVDTs integrated in the actuators.

The EEC controls the operation of the Turbine Impingement Cooling (TIC) valve by the TIC solenoid valve. There is no feedback of the TIC valve position.

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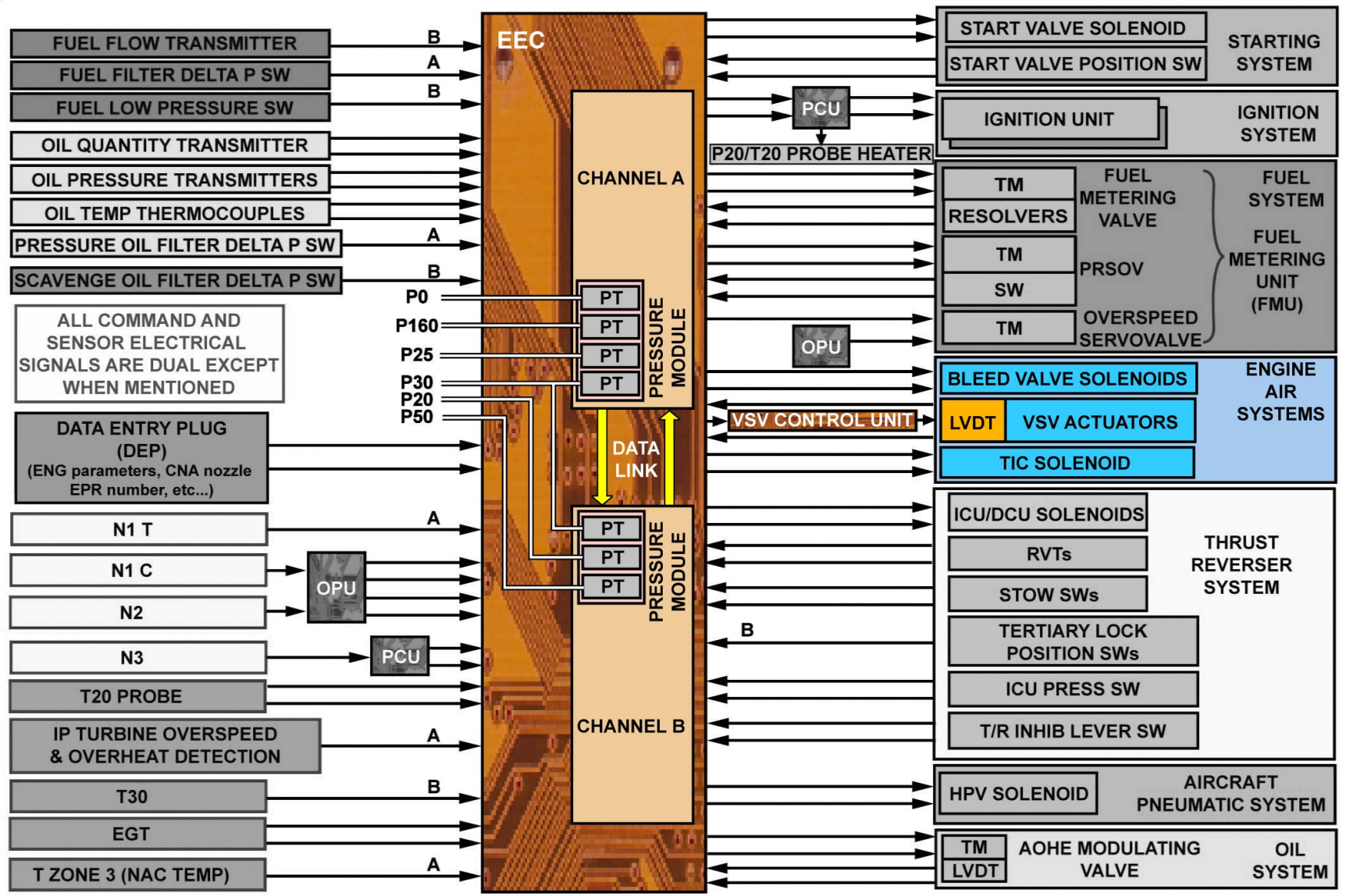

EEC - ENGINE INTERFACE - ENGINE AIR SYSTEM

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

THRUST REVERSER SYSTEM

The EEC controls the hydraulic operation of the thrust reverser pivoting doors. To operate the thrust reverser, the EEC sends command signals to the Isolation Control Unit (ICU) and the Direction Control Unit (DCU). The ICU and DCU direct hydraulic pressure to unlock, deploy and stow the thrust reversers.

The EEC receives feedback signals for control and monitoring from:

- the 4 Rotational Variable Transducers (RVTs),
- the 4 stow switches,
- the 4 tertiary lock position microswitches,
- the ICU pressure switch,
- the thrust reverser inhibit lever switch.

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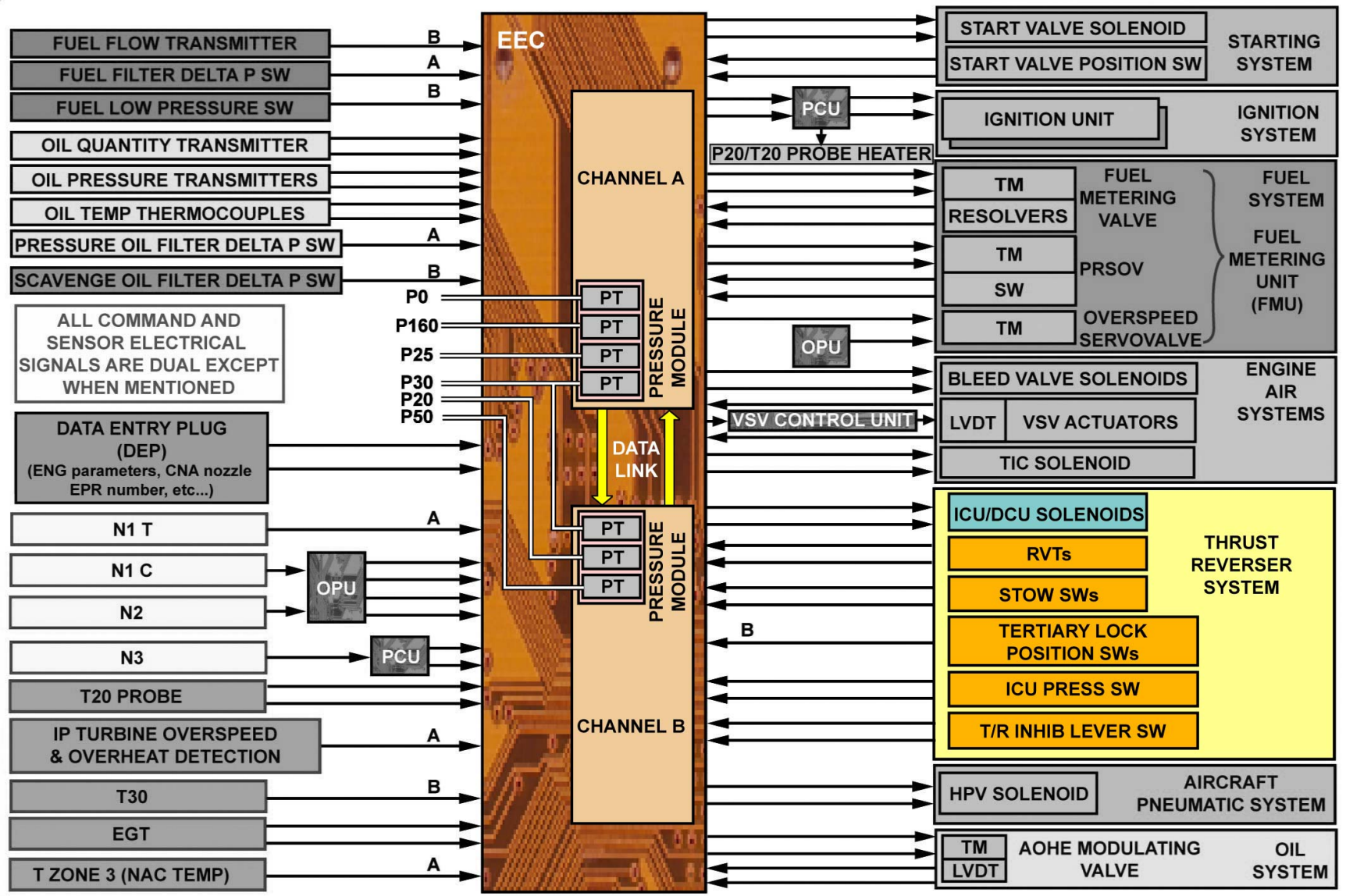

EEC - ENGINE INTERFACE - THRUST REVERSER SYSTEM

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

AIRCRAFT PNEUMATIC SYSTEM

In some operating conditions, the EEC controls the High Pressure Valve (HPV) closed by energizing the HPV dual-coil solenoid (Channel A or B control).

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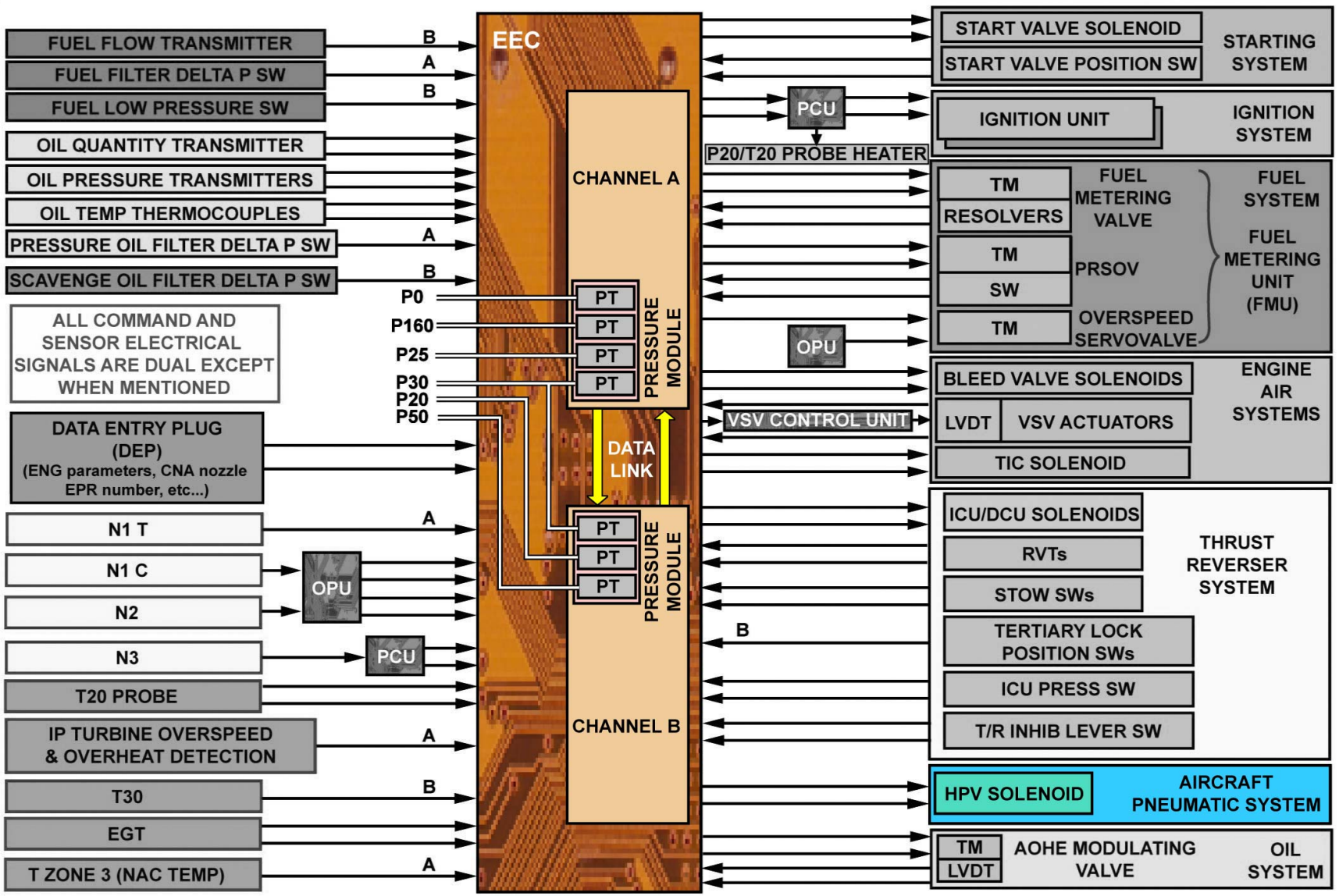

EEC - ENGINE INTERFACE - AIRCRAFT PNEUMATIC SYSTEM

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

OIL SYSTEM

As part of the engine heat management control, the EEC controls the operation of the Air Oil Heat Exchanger (AOHE) air modulating valve. A torque motor in the valve supplies servo fuel pressure to operate the valve. When the valve opens, LP air is ducted across the heat exchanger to decrease the oil temperature. The valve also has an LVDT for position feedback to the EEC.

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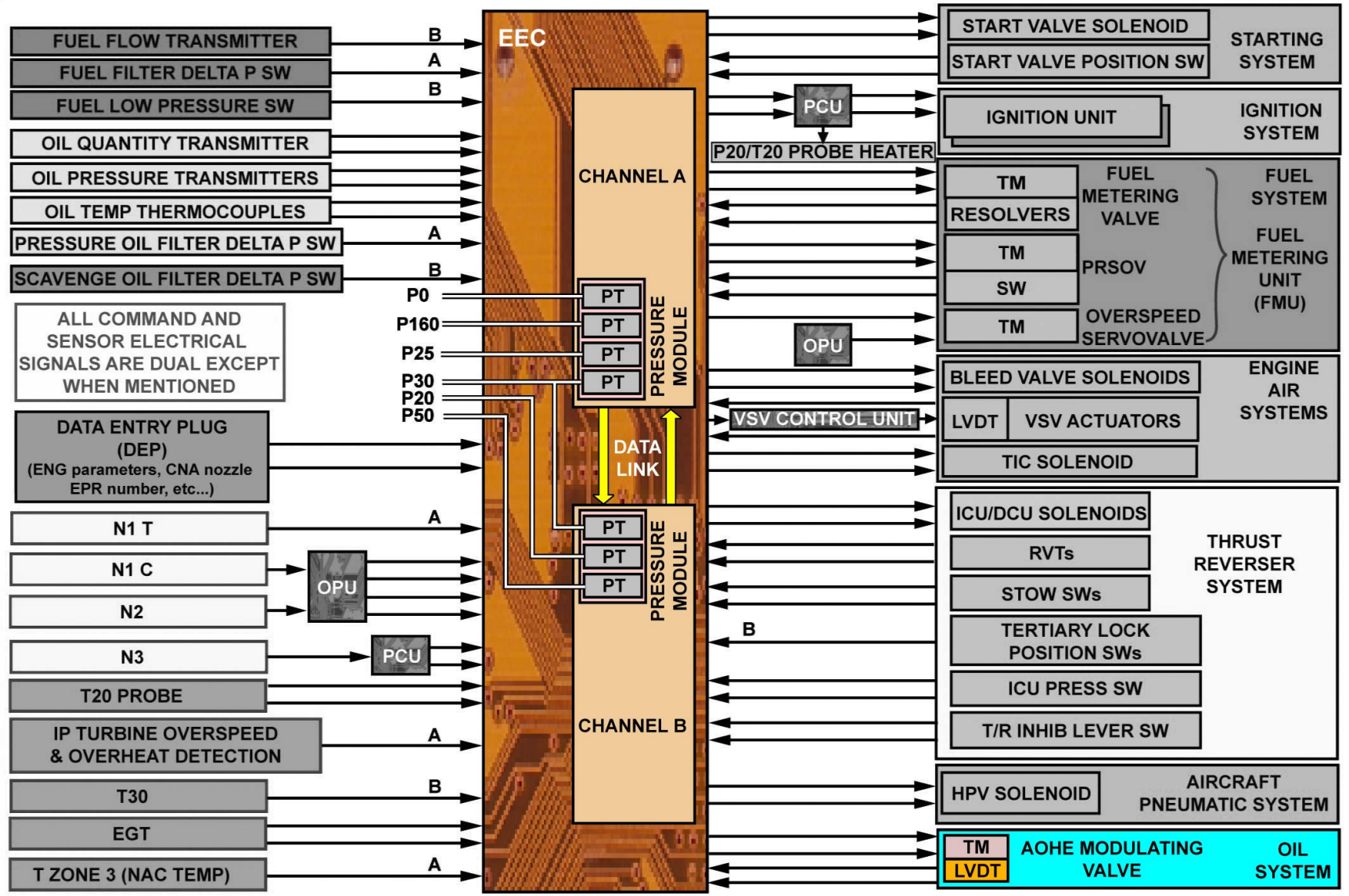

EEC - ENGINE INTERFACE - OIL SYSTEM

FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

STARTING SYSTEM INPUTS/OUTPUTS

The EEC electrically controls the operation of the starter control valve for automatic engine start, and manual engine start engine motoring. The EEC energizes the starter control valve solenoid and receives feedback on valve position from a position switch.

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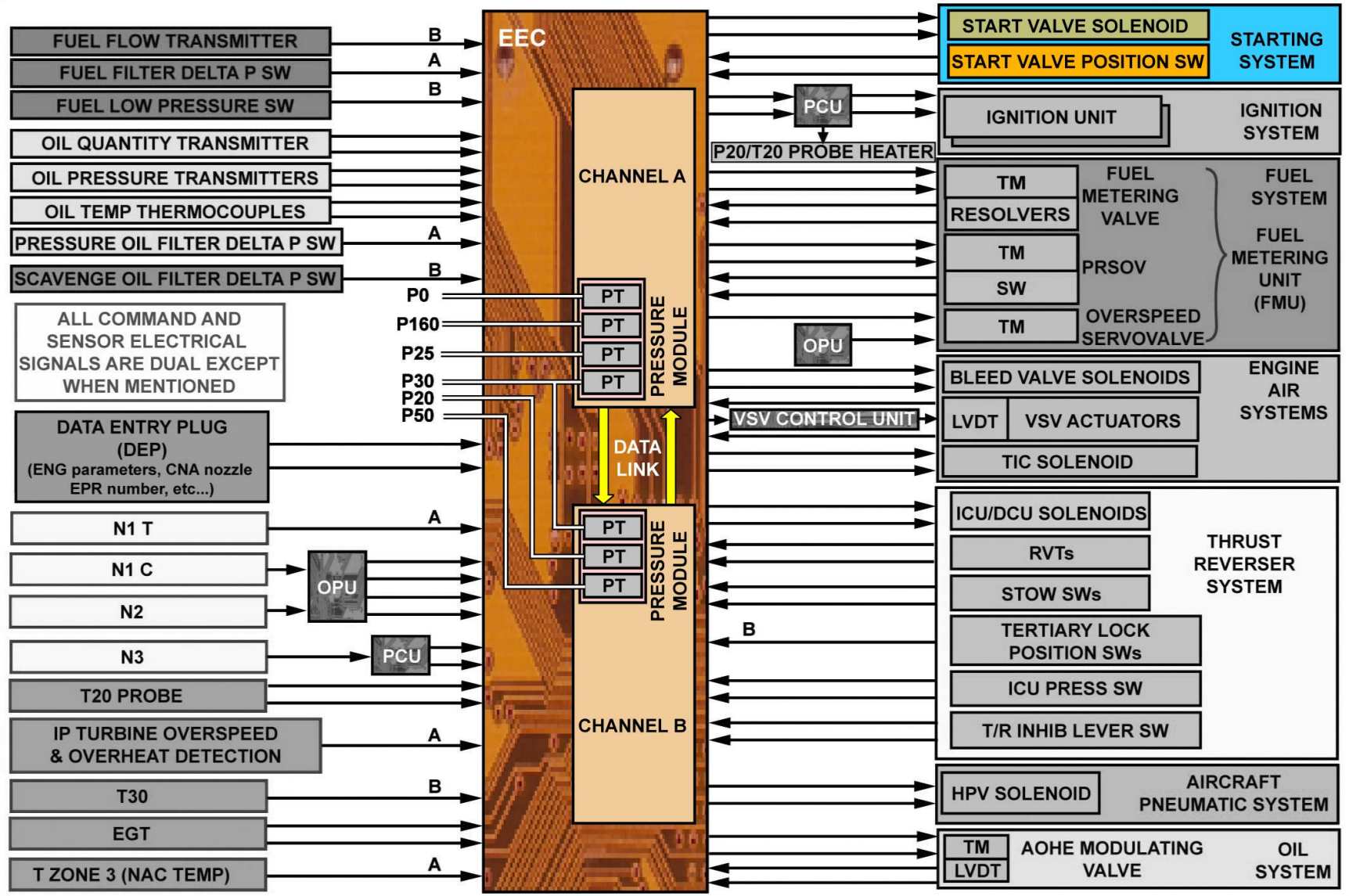

EEC - ENGINE INTERFACE - STARTING SYSTEM INPUTS/OUTPUTS

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

IGNITION SYSTEM INPUT

The EEC controls the two ignition systems. The EEC channel A controls one ignition system and the EEC channel B controls the other system. The PCU channels A and B supply each system independently.

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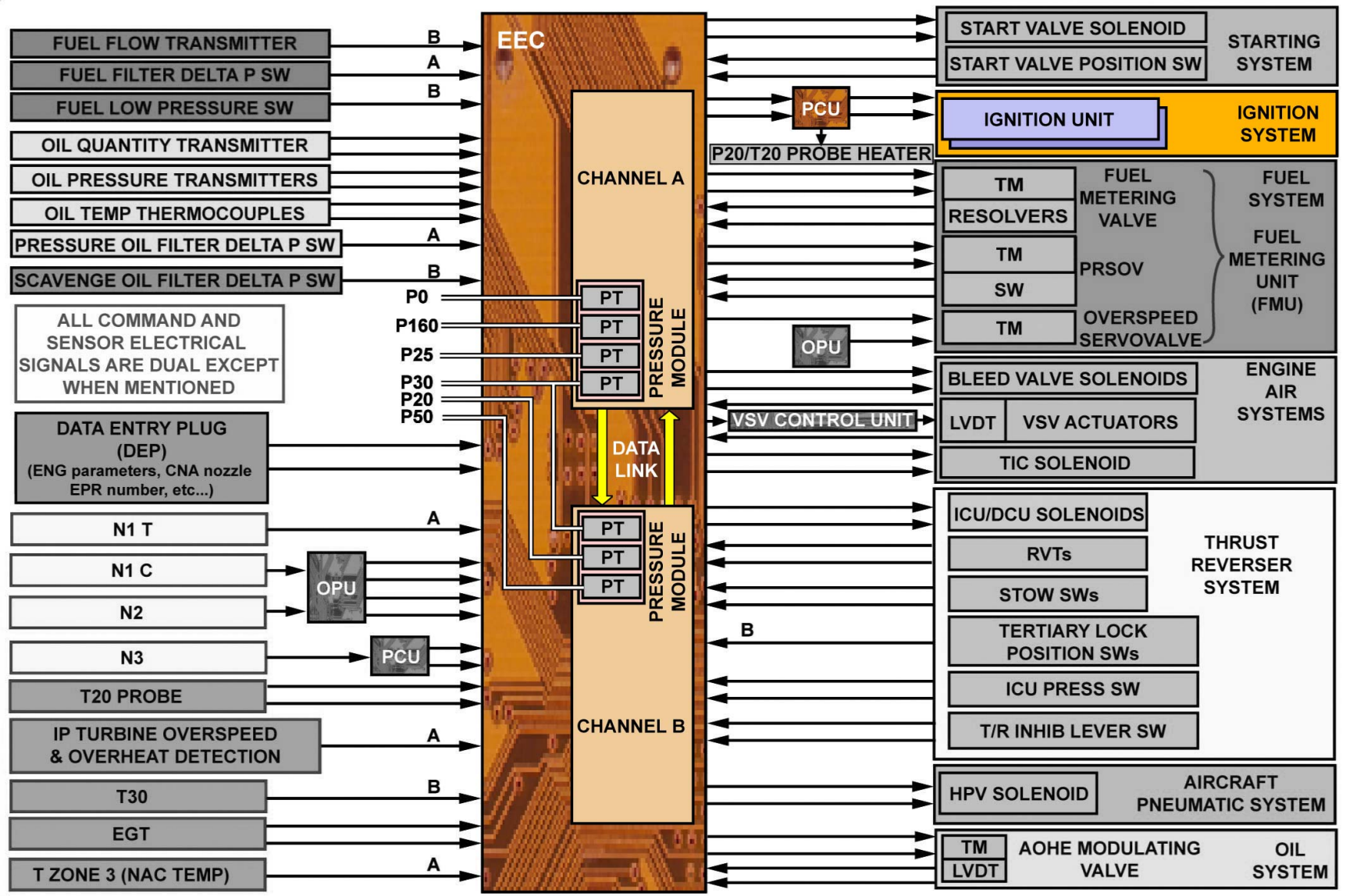

EEC - ENGINE INTERFACE - IGNITION SYSTEM INPUT

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

P20/T20 PROBE HEATING

Since the P20/T20 probe is installed in the inlet, heating elements are necessary to prevent icing and make sure that accurate data is sent to the EEC for engine control. These heating elements are supplied with 115 VAC through the PCU.

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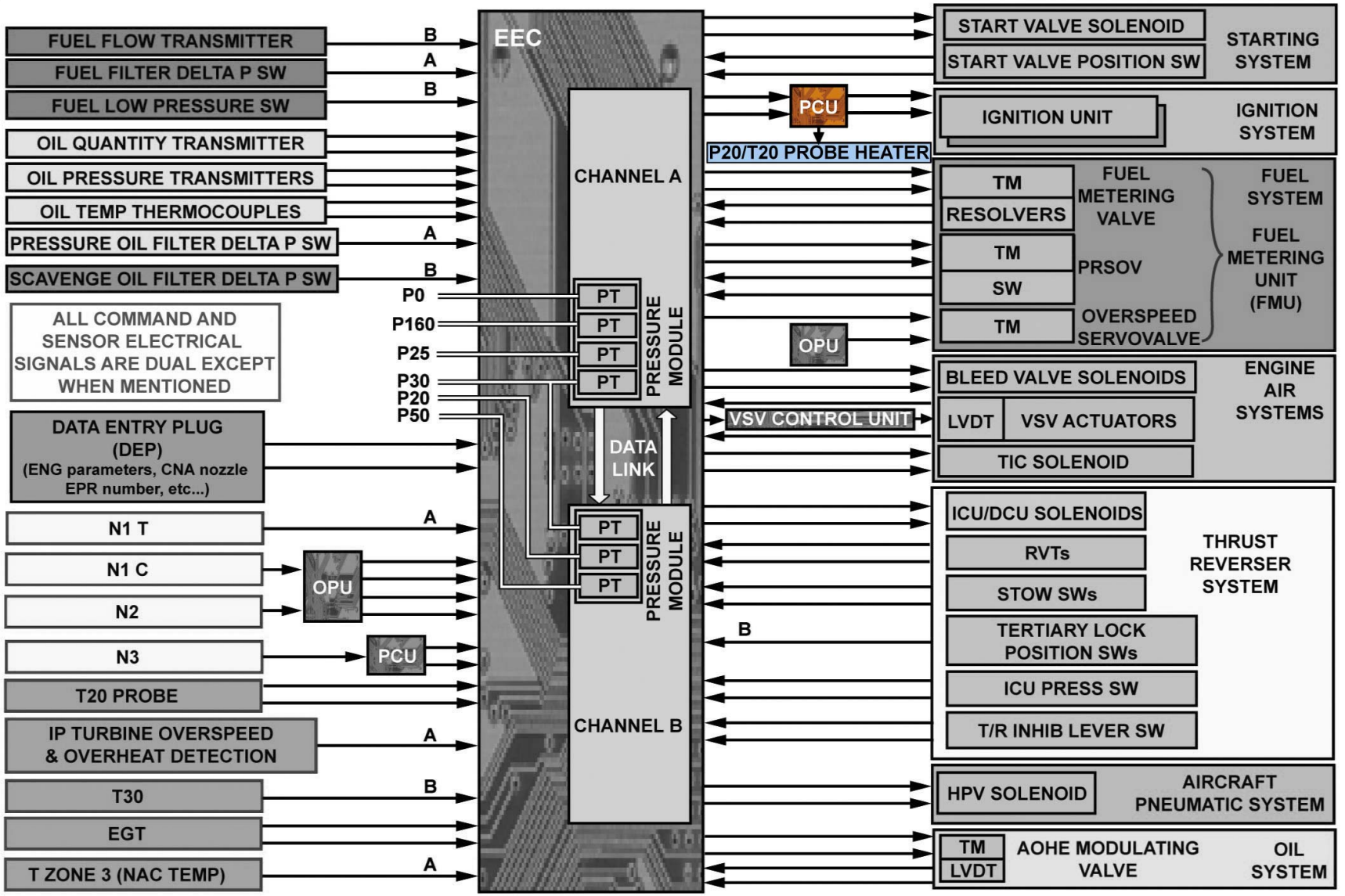

EEC - ENGINE INTERFACE - P20/T20 PROBE HEATING

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

ENGINE PARAMETER INPUTS FOR CONTROL, MONITORING AND INDICATION

A fuel flow transmitter continuously monitors the fuel flow delivered to the fuel nozzles. It supplies electrical signals to the EEC that are in proportion to the fuel flow going through the transmitter. The EEC uses these signals to calculate the fuel flow rate and the quantity of fuel that has been used by the related engine (fuel used). The EEC then transmits this data to display on the ECAM.

A fuel filter differential pressure switch and a fuel low-pressure switch continuously monitor the condition of the LP fuel supply. In case of high differential pressure (fuel filter clogging), the P switch sends a signal to the EEC channel A. This signal is used to generate the FUEL CLOG warning on the ECAM. In case low fuel pressure downstream of the LP fuel pump, the low-pressure switch sends a signal to the EEC channel B. This signal is used to generate the related CMS fault message.

The oil quantity transmitter is installed in the top of the oil tank. The transmitter signal is sent to the EEC and is used for oil quantity indication on the ECAM. Two oil pressure transmitters (one for each EEC channel) send oil pressure signals to the EEC. This transmitter signal is used for oil pressure indication on the ECAM.

The oil temperature thermocouples are installed on the top of the scavenge oil filter housing. These thermocouples send oil temperature inputs to the EEC. This signal is used for oil temperature indication on the ECAM.

The pressure and scavenge oil filters are monitored by P switches. In case of high differential pressure (oil filter clogging), the related P switch sends a signal to the EEC. This signal is used to generate the OIL CLOG warning on the ECAM.

The oil system is also monitored by a low oil pressure switch, which IS NOT connected to the FADEC. The switch is triggered when the engine oil pressure drops below 25 psi. The low oil pressure signal is sent directly to the FWC to generate an emergency warning.

The LP (N1) shaft speed and IP (N2) shaft speed signals are given respectively by three N1 speed sensors and three N2 speed sensors. The sensors are located internally in the forward bearing compartment. The N1 and N2 speed signals are sent to both EEC channels, via the Overspeed Protection Unit (OPU) for engine control, overspeed protection and indication on ECAM.

Three LP turbine speed probes send signals directly to EEC channel A. LP turbine speed and LP compressor (N1) speed signals are compared in the EEC to detect LP shaft breakage.

The EEC dedicated alternator is used to sense HP (N3) shaft speed. The dedicated alternator is driven by the gearbox which is in turn is driven by the HP shaft. The output of the dedicated alternator is at a frequency proportional to the HP shaft speed and provides an N3 speed signal for each channel of the EEC through the PCU. The EEC sends the N3 signal to ECAM for indication.

The T20 thermocouples measure air temperature at the fan inlet. The thermocouples are part of the P20/T20 probe located at the 12 o'clock position in the inlet. The dual T20 thermocouples send the temperature signal to both EEC channels.

The EEC monitors the temperature of the air supplied to the combustion chamber (T30) with three thermocouples mounted at equal distances around the combustion chamber outer case. The thermocouples are connected in parallel and electrically connected to the EEC channel B. T30 is used as a control parameter to make sure an engine flame-out is prevented during bad weather conditions (such as heavy rain and/or hail).

Two dual-thermocouples are installed on the IP turbine case to measure the air temperature across the IP turbine disk. The FRONT and REAR thermocouples send signals to both channels of the EEC. If the

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temperature becomes excessive, first the EEC automatically limits the engine thrust up to 55% of the maximum take-off thrust, to protect the integrity of the IP turbine, and a level 2 ENG THRUST LIMITED warning is generated (IPTOS function of the EEC). If the temperature is still increasing, a level 3 ENG TURBINE OVHT warning is generated with a pilot action to shut down the engine.
The Exhaust Gas Temperature (EGT) indication comes from 11 dual thermocouples. The EGT thermocouples are wired in parallel and the average temperature is sent to both EEC channels for the ECAM display and engine limit protection.
A single thermocouple located in Zone 3 (lower engine core area) sends the nacelle temperature signal to the EEC channel A for indication on the ECAM.

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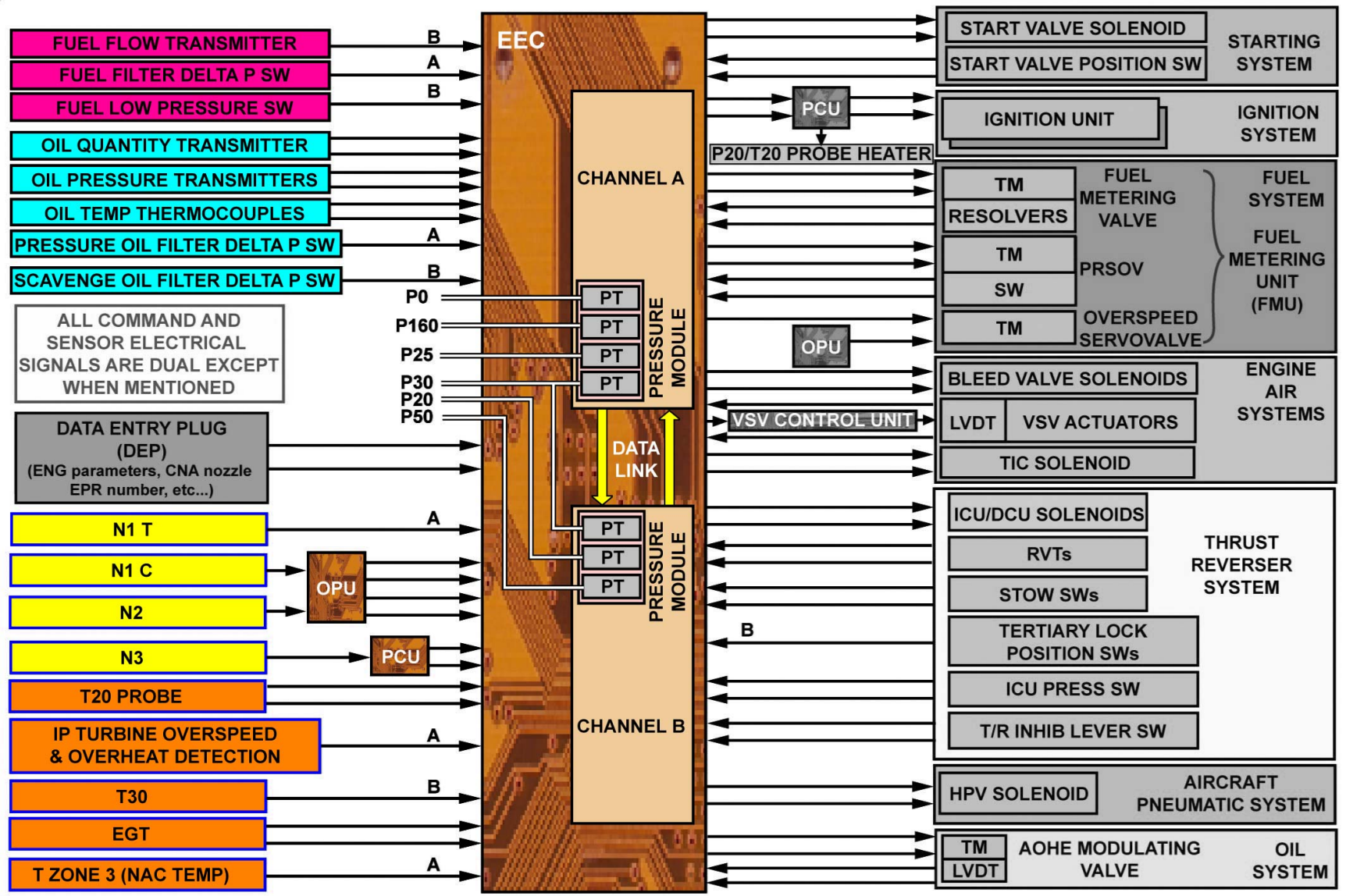

EEC - ENGINE INTERFACE - ENGINE PARAMETER INPUTS FOR CONTROL, MONITORING AND INDICATION

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

PRESSURE MODULE

The pressure module is installed within the EEC and is divided into two parts, one for each channel. Pressure lines are connected to the pressure module internal pressure transducers and sent to both EEC channels internally.

The EEC uses the following pressure signals:

- P0 - Atmospheric static pressure for engine control,
- P20 - Fan inlet pressure for EPR calculation,
- P160 - Fan outlet pressure for condition monitoring,
- P25 - HP compressor inlet pressure for condition monitoring,
- P30 - HP compressor outlet pressure for engine control,
- P50 - LP turbine outlet pressure for EPR calculation.

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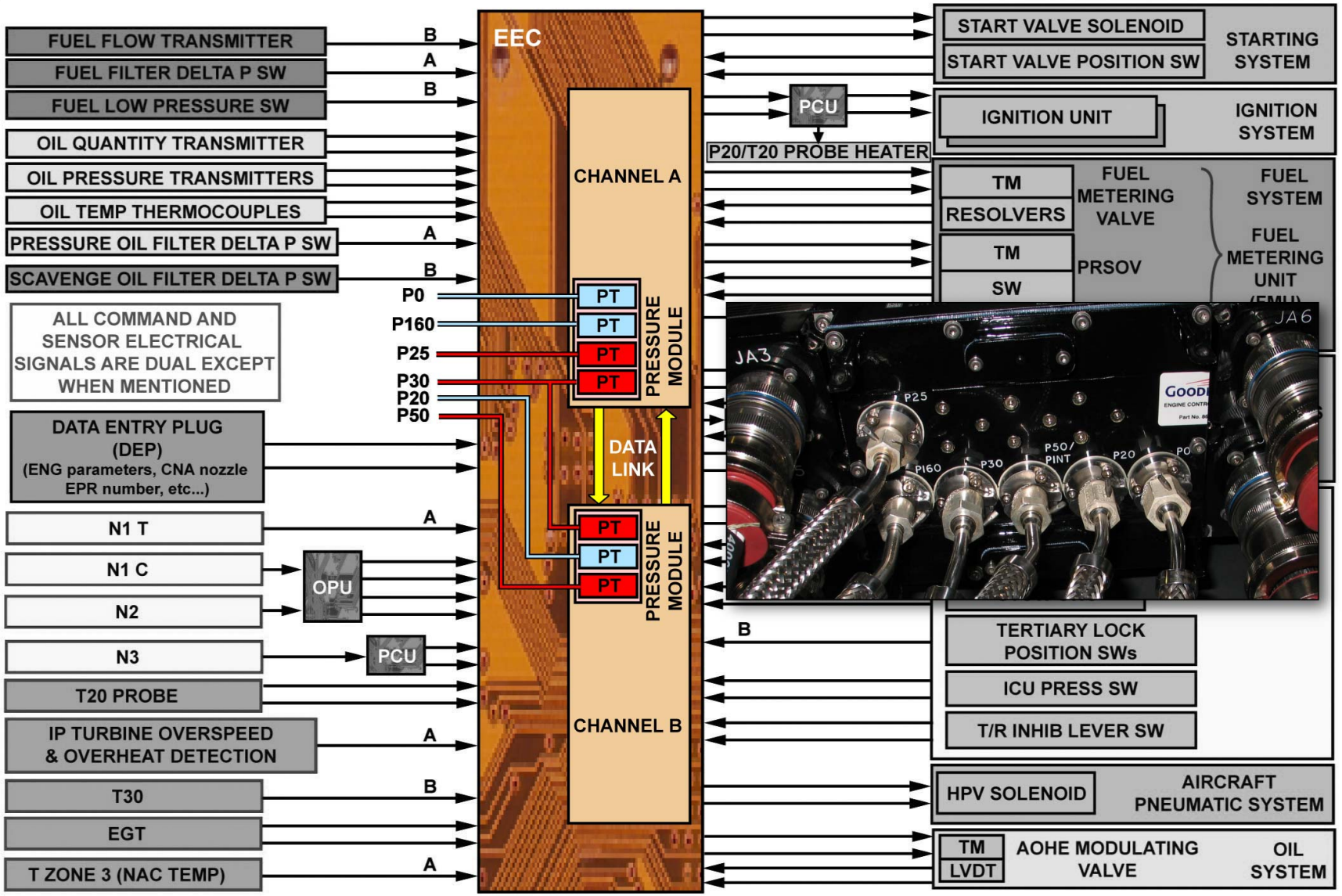

EEC - ENGINE INTERFACE - PRESSURE MODULE

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FADEC D/O (3)

EEC - ENGINE INTERFACE (continued)

DATA ENTRY PLUG

The Data Entry Plug (DEP) is a dual channel serial memory device supplying storage for engine specific performance and configuration information. The DEP includes a plug and housing, which is fastened to the engine by a lanyard.

Two EEPROM (Electrically Erasable Programmable Read Only Memory) devices are located inside the plug, one EEPROM being allocated to each of the two channels of the EEC.

Both DEP EEPROMs are programmed with identical data:

- Engine serial number: The EEC needs to know which engine is mounted on,
- Ratings/Bump: All data related to the available ratings and bump are stored in the EEC and the DEP index is used only as a means of selection,
- EPR trim: The EEC trims the value of measured EPR in order to make every engine of a particular built standard appear identical to the aircraft,
- EGT trim: The actual EGT limit allowed by the certification authorities may vary over the life of an engine project due to changes of turbine entry temperature clearance and/or due to engine modifications. However to reduce pilot confusion, all Trent 700 engines will appear to have the same red line EGT on the ECAM,
- Engine standard,
- Intermix/retrofit: Enables different standards of engine to be used on the same aircraft and operates to the same rating,
- Fan stall index (provision): The EEC contains provision for software to detect, annunciate and avoid fan stall events,

Idle point trim: To enable trimming of the engine idle speeds for minimum modulated idle and approach idle requirements.

NOTE: The engine F/H and F/C data are not stored in the DEP. After engine replacement they have to be updated manually via the ACMS "SPECIAL FUNCTION/REPROGRAMMING" menu (AMM 31-36-00).

The EEC reads the DEP content during power-up test on ground and does the validation checks on the download data. The data is then compared to separate copies stored in the Non-Volatile Memory (NVM) of both EEC channels. If the DEP data differs from the NVM data, and there were no faults detected, then the EEC updates its NVM with this new data.

The programming of the DEP requires a dedicated programmer. It is also used to read or erase the contents of the DEP.

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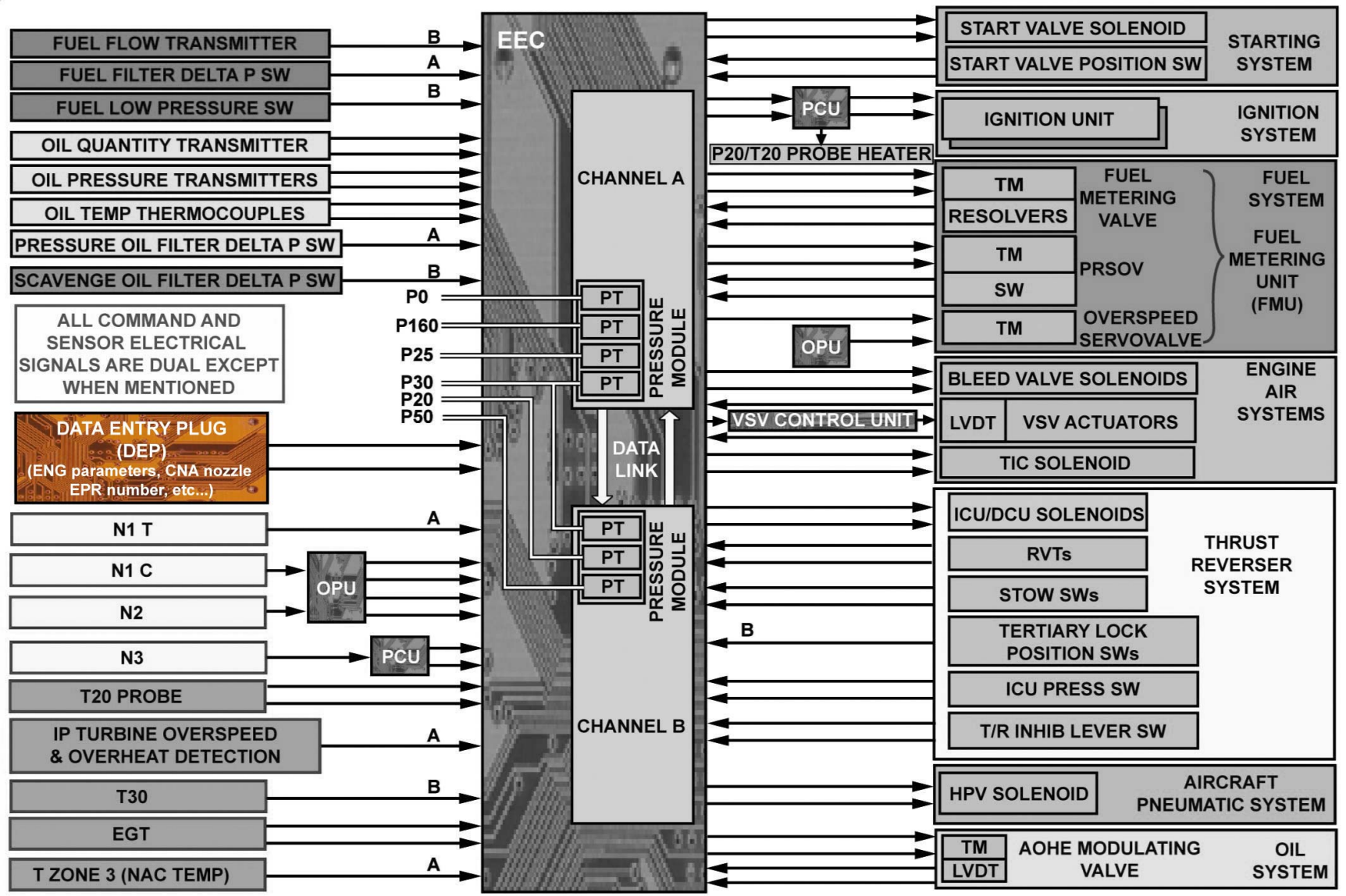

EEC - ENGINE INTERFACE - DATA ENTRY PLUG

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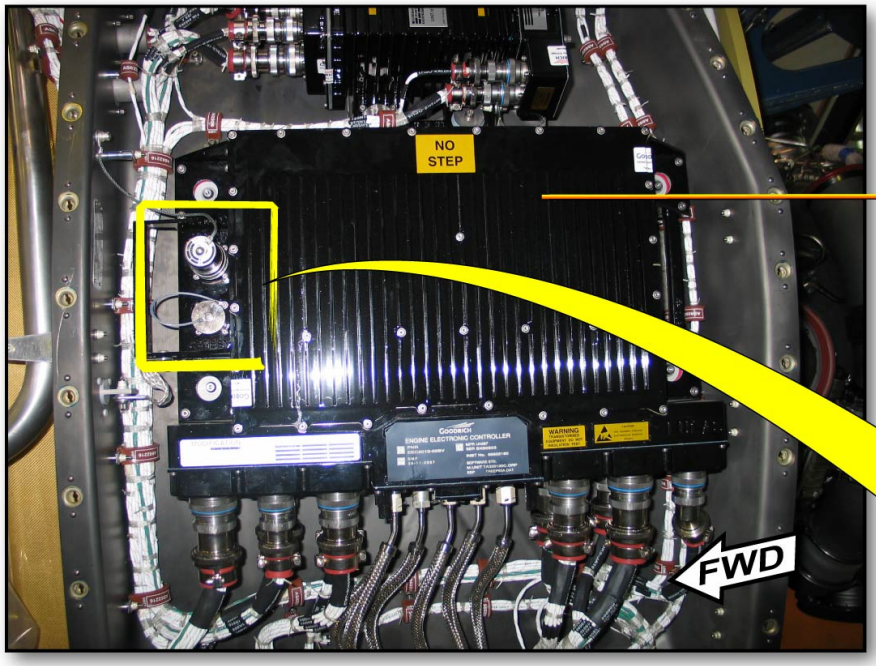


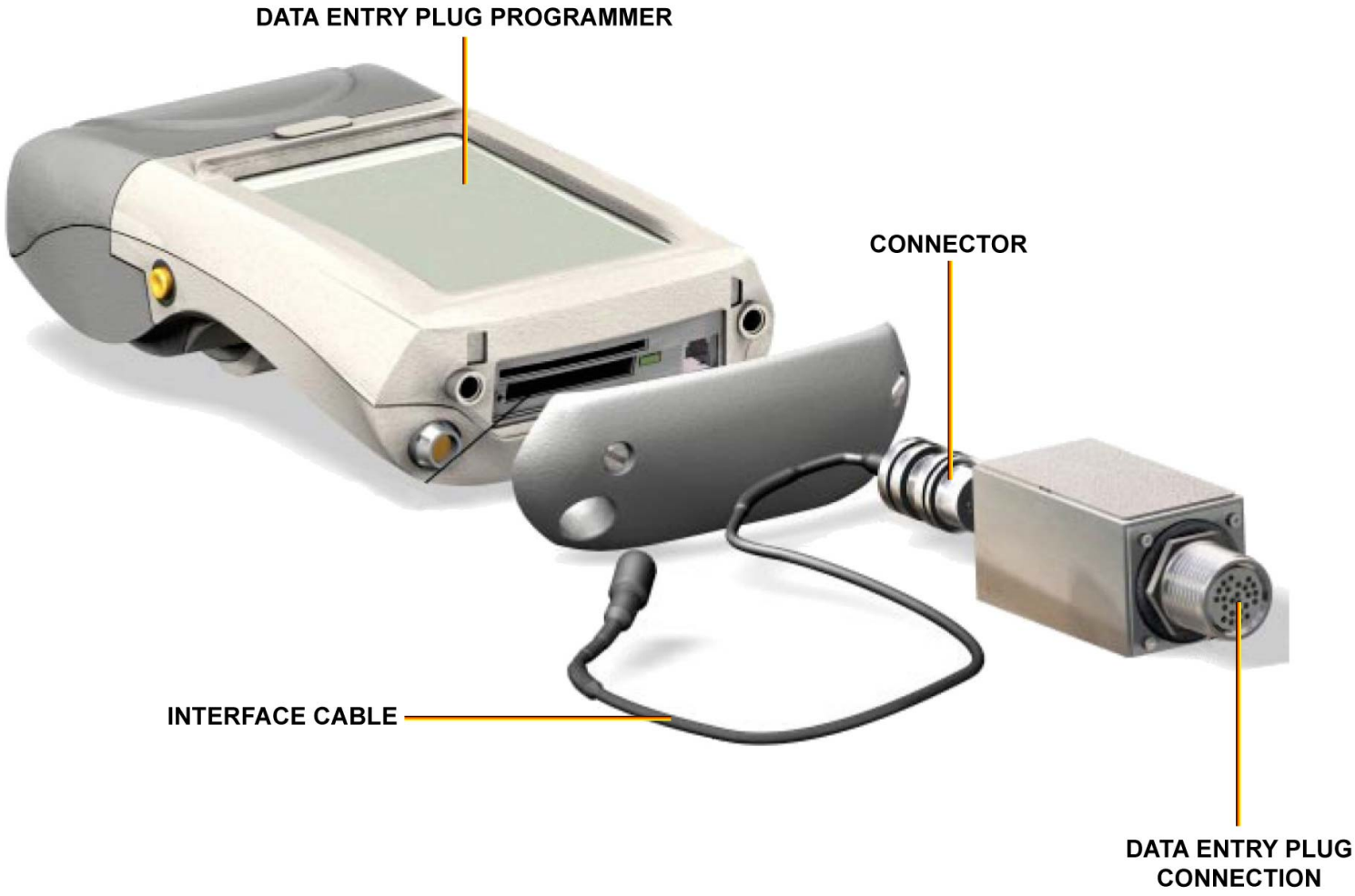
EEC

DATA ENTRY PLUG

LEFT VIEW ENGINE

INFORMATIONS STORED IN THE DEP:
- EPR TRIM
- CNA EPR NUMBER
- ENGINE RATING SELECTION
- EGT TRIM
- ENGINE SERIAL NUMBER
- ENGINE INTERMIX
- FAN STALL INDEX
- ENGINE BUILD STANDARD
- IDLE TRIM

EEC - ENGINE INTERFACE - DATA ENTRY PLUG



EEC - ENGINE INTERFACE - DATA ENTRY PLUG

FADEC D/O (3)

EEC - AIRCRAFT INTERFACE

The FADEC system interfaces with A/C systems and cockpit controls. The EEC receives and sends digital, discrete and analog data. There are two methods of data exchange between the FADEC (EEC) and the aircraft. Essential data exchange is DIRECT from the aircraft system to the EEC. All other data exchange is through the Engine Interface and Vibration Monitoring Unit (EIVMU). The EIVMU, installed in the avionics bay, concentrates both digital and discrete signals from the cockpit and other computers to communicate with the EEC via a digital bus.

DIRECT INPUT TO EEC

Each channel of the EEC has inputs from Air Data and Inertial Reference Units (ADIRU 1 & 2). Each ADIRU supplies data to both channels of EEC 1 and EEC 2.

Each EEC channel receives digital data buses from two ADIRUs, which supply:

- corrected static pressure signals (PS),
- total air temperature signals (TAT),
- total air pressure signals (PT).

Throttle control lever inputs are used for manual engine control. Two mechanically coupled resolvers in the Thrust Control Unit (TCU) monitor the angular position of the throttle control lever. These signals are the Throttle Resolver Angle (TRA).

The EEC supplies the resolver excitation current and the TRA signals are directly hardwired from the resolvers to both channels of the EEC creating a closed loop system. The A/THR instinctive disconnect pushbutton switch on the throttle control levers generates a discrete signal which is also hardwired to the EEC.

The Bleed Monitoring Computer (BMC) sends the HPV closure command discrete signal to the EEC channels A through a relay. BMC1 signals EEC 1 and BMC2 signals EEC 2.

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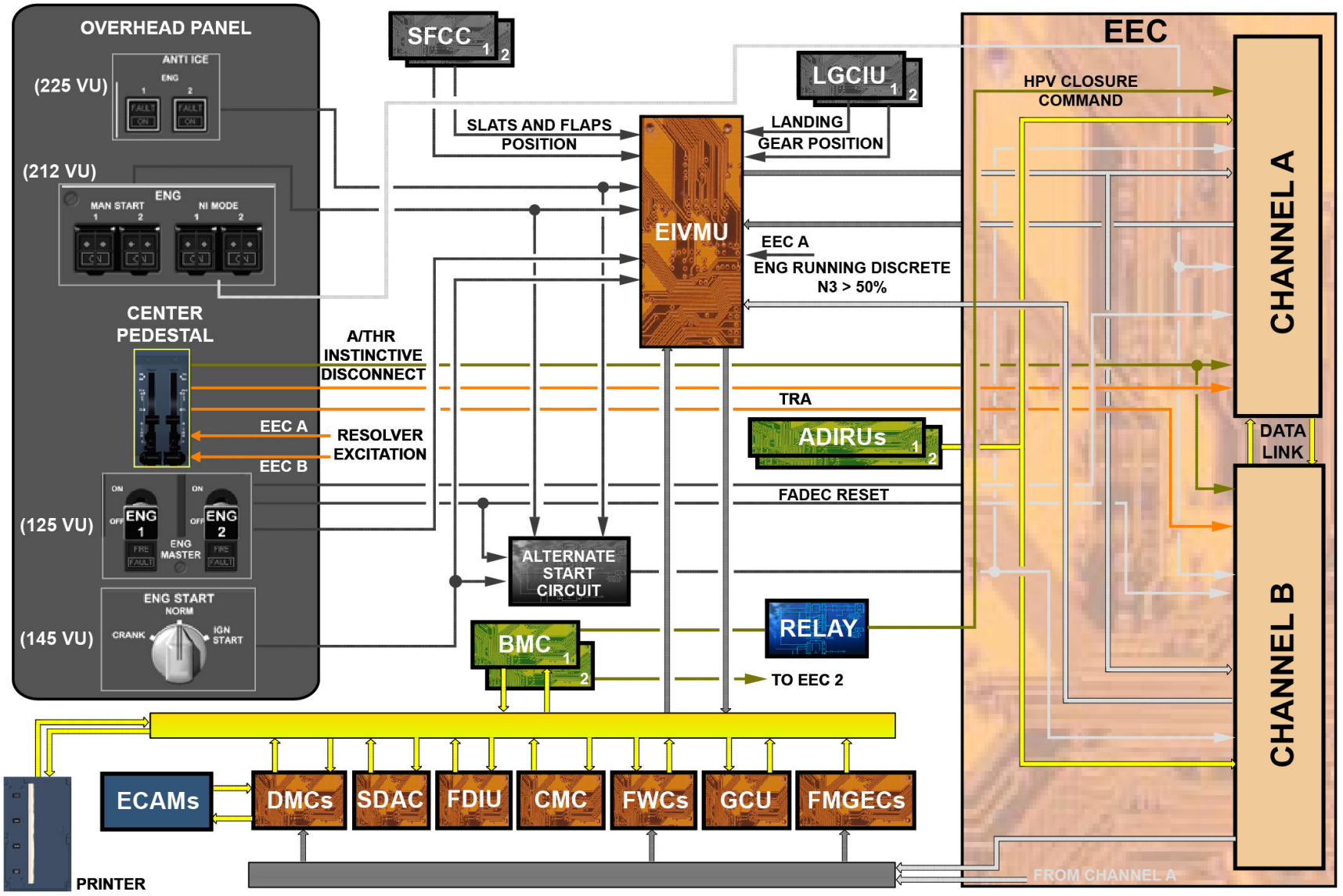

EEC - AIRCRAFT INTERFACE - DIRECT INPUT TO EEC

FADEC D/O (3)

EEC - AIRCRAFT INTERFACE (continued)

INPUT TO EEC FROM THE EIVMU

The EIVMU, installed in the avionics bay, interfaces with various A/C computers and controls and with the EEC for the following main functions:
- transmission of cockpit panel and A/C computer data to the EEC,
- internal processing of A/C status signals needed by the EEC,
- control of A/C electrical supplies to the EEC,
- engine to engine segregation,
- internal processing of engine status signals needed by A/C systems,
- engine vibration signal processing and monitoring.

The following categories of A/C data are transmitted by the EIVMU to the EEC:
- general A/C data,
- idle setting data,
- engine starting data,
- A/THR function data,
- maintenance function data.

In normal operation, the EEC uses inputs from the ENGine START, ENGine MASTER, ENGine MANual START and ANTI ICE panels to control engine starting, continuous ignition and engine shut down. These switch positions are transmitted from the cockpit to the EEC on the EIVMU digital data bus. These cockpit panels have their selectors and pushbuttons hardwired to the EIVMU. The different positions of these rotary selectors and pushbuttons are sent to the EIVMU, which sends the related signals to the EEC through an ARINC data bus connection.

The main source of ENGine MASTER switch position for the EEC is the EIVMU. In case of non-validity of the ENGine MASTER switch position information contained in the EIVMU bus, the EEC can use a hardwired discrete which is also used as a "reset" input. The EEC uses Engine Pressure Ratio (EPR) as the main engine control parameter. If the EEC is unable to calculate the EPR, the active channel selects automatically the N1 control mode. The operator is then advised to select both engines to the N1 control mode. The ENGine N1 MODE signal is hardwired to the EEC.

To initiate the engine control functions when the EIVMU data is not available, the EEC receives a hardwired alternate start circuit discrete signal. The EEC via the EIVMU receives the SFCCs and LGCIUs signals.

The Slat/Flap Control Computers (SFCCs) send the slat and flap position to the EEC and the Landing Gear Control and Interface Units (LGCIUs) send the landing gear position signal to the EIVMU, which sends it to both channels of the EEC via a digital bus.

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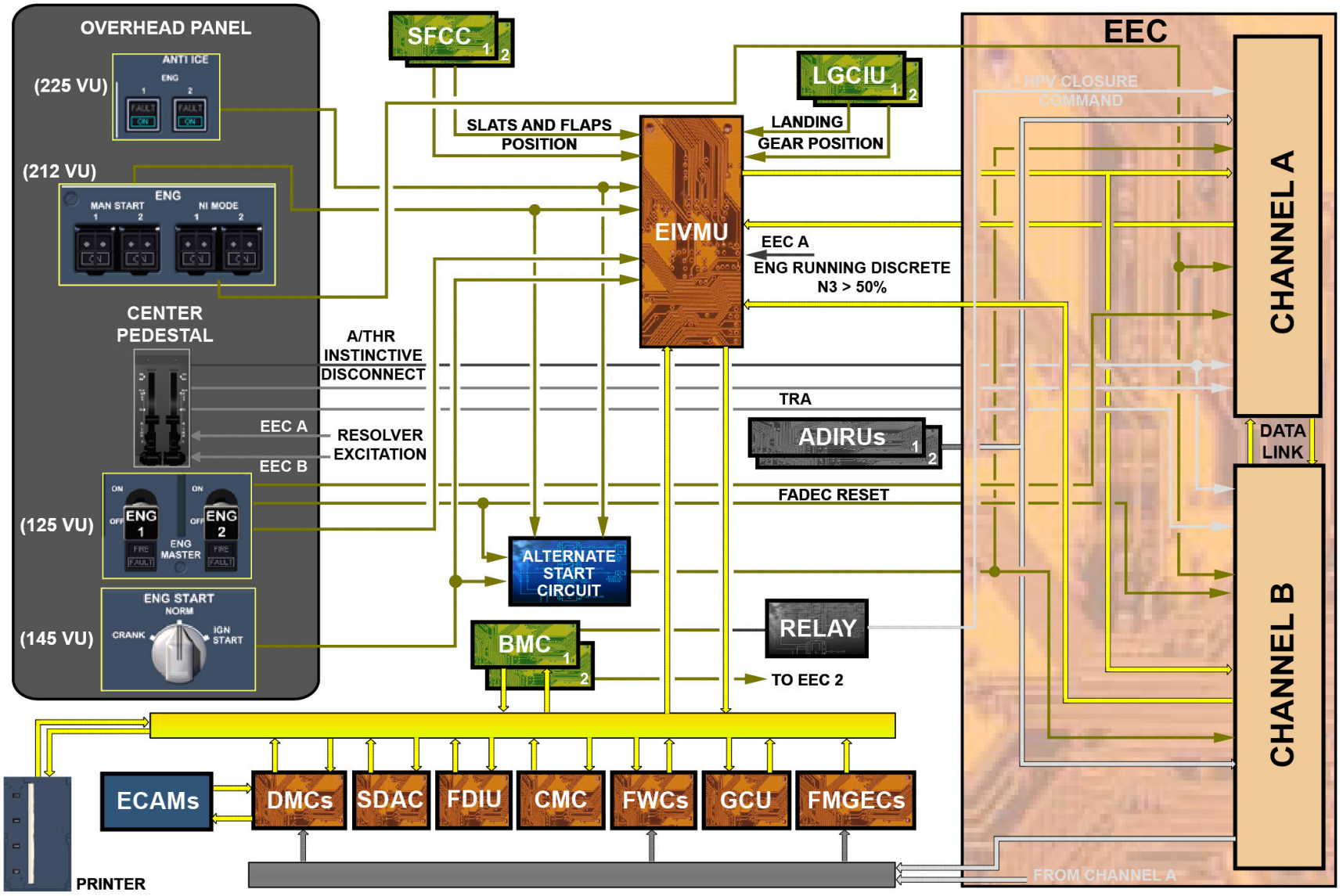

EEC - AIRCRAFT INTERFACE - INPUT TO EEC FROM THE EIVMU

FADEC D/O (3)

EEC - AIRCRAFT INTERFACE (continued)

EEC DISCRETE AND DIGITAL OUTPUT

The engine running hardwired discrete indicates to the A/C, via the EIVMU, whether or not the engine is running (N3>50%).
The EEC transmits data to the A/C systems through four high-speed digital busses. The information contained on the output busses include the following general items:
- engine rating parameter information,
- parameters used for engine control,
- FADEC system maintenance data,
- engine condition monitoring parameters,
- EEC status and fault information,
- propulsion system status and fault information.

The EEC digital outputs are received by the following A/C computers:
- EIVMU,
- Flight Warning Computers (FWCs),
- Display Management computers (DMCs),
- Flight Management Guidance and Envelope Computers (FMGECs).

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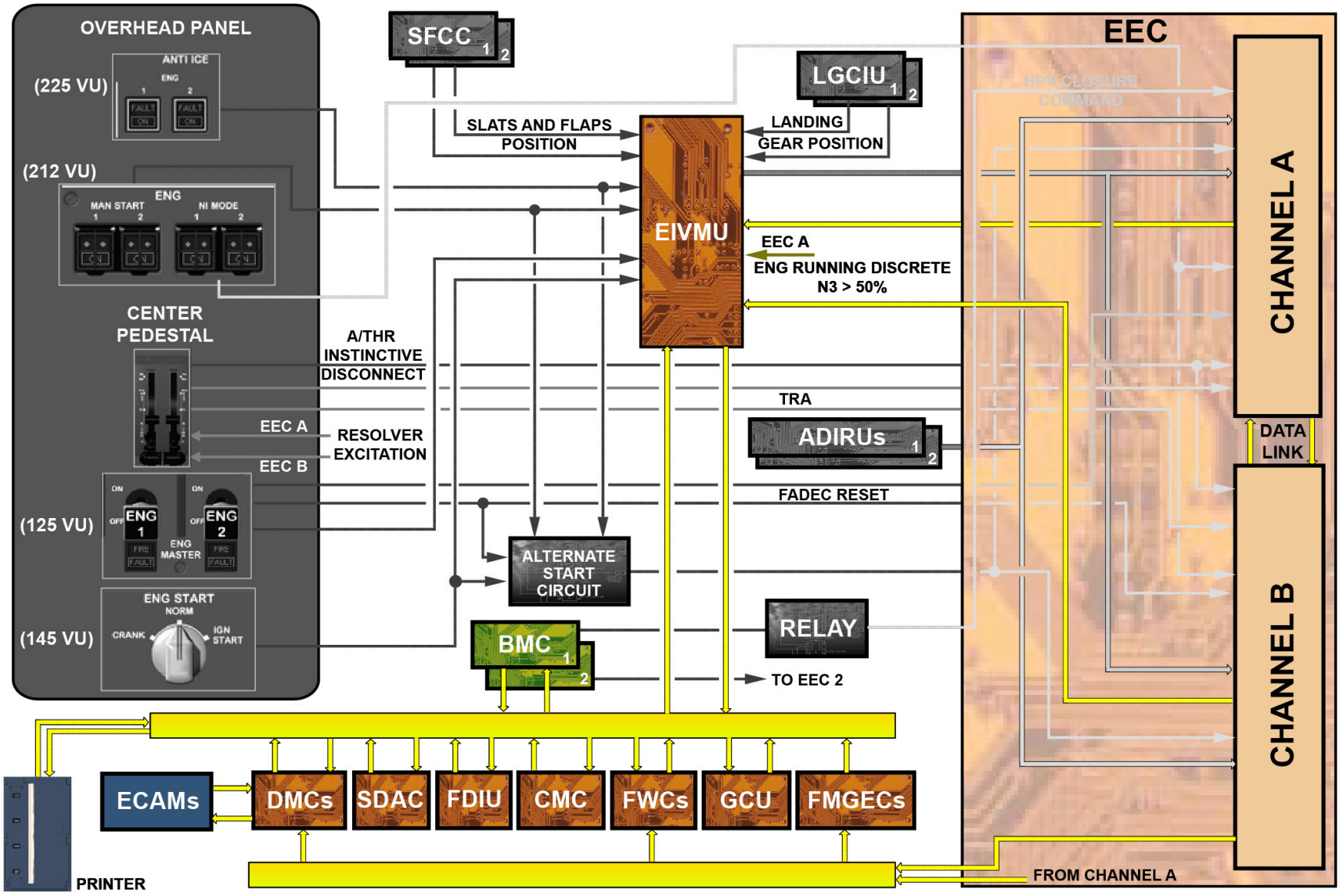

EEC - AIRCRAFT INTERFACE - EEC DISCRETE AND DIGITAL OUTPUT

EIVMU INTERFACES (3)

EEC INTERFACES

The Engine Interface and Vibration Monitoring Unit (EIVMU) is linked to the Engine Electronic Controller (EEC) by one output bus and by two identical input buses which carry exactly the same information. The EIVMU takes its information automatically from the "better" bus in case of transmission problems. The EIVMU controls the power cut-off for EEC, the ignitors and the thrust reverser Directional Control Valve (DCV). The EIVMU interfaces signals and data between aircraft computers, cockpit panels and EEC (display data, monitoring data for maintenance use).

ECS INTERFACE

The EIVMU receives one input bus from the Environmental Control System (ECS). This bus gives information from the active channel of the Zone Controller (ZC) (lane 1 or lane 2). The ECS determines the various air bleed configurations according to the demands of the air conditioning, wing anti-ice and nacelle anti-ice systems. This information is transmitted by the EIVMU to the EEC to compute the bleed air demand required at the engine customer bleed ports.

ENGINE START CONTROL

The EIVMU receives all starting ignition and cranking signals from the cockpit engine control panels and sends them to the EEC in digital format through its ARINC buses. The control panels send the following signals to the EIVMU:
- ENG START mode selector position,
- ENG MASTER switch position,
- MAN START P/B selection.

OTHER INTERFACES

The EIVMU also receives and generates signals for control and monitoring purposes from and to various aircraft systems.

DIGITAL INPUTS

The EIVMU receives digital inputs from:
- Flight Control Unit (FCU) for Auto Flight System (AFS) and A/THR signals,
- Central Maintenance Computer (CMC) for interrogation through MCDU.

DISCRETE INPUTS

The EIVMU receives discrete inputs from:
- Throttle Control Unit (TCU)(reverser condition) for deployment permission,
- Slat Flap Control Computer (SFCC) for slat/flat lever position and approach idle selection,
- Landing Gear Control and Interface Unit (LGCIU) for flight/ground logic,
- low oil pressure switch for low oil pressure on ground discrete output processing,
- engine running (N3 above 50%) signal from EEC.

ANALOG INPUTS

The EIVMU receives analog inputs from the engine bleed regulated pressure transducer.

VIBRATION PROCESSING

The EIVMU receives analog inputs for vibration processing from:
- fan trim balance probe for N1 "once per revolution" signal,
- Remote Charge Converter (RCC) for vibration transducers (dual accelerometers) signals.

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DIGITAL OUTPUTS

The EIVMU sends digital outputs to:
- Bleed Monitoring Computer (BMC) for ECS interface,
- Data Management Unit (DMU) for Aircraft Condition Monitoring System (ACMS),
- Flight Data Interface Unit (FDIU) for the flight data recording system,
- System Data Acquisition Concentrator (SDAC) for the Electronic Instrument System (EIS),
- Display Management Computer (DMC) for the EIS,
- CMC.

DISCRETE OUTPUTS

The EIVMU sends discrete outputs for:
- engine running to the Radio Altimeter (RA), Weight and Balance System (WBS), electric hydraulic pump selection, Ram Air Turbine (RAT) activation, alternate start discrete, limitation flight control change speed, electrical power cut-off,
- Auxiliary Power Unit (APU) boost: to the Electronic Control Box (ECB) to obtain main engine start bleed mode,
- pack valve closure: pack flow control valve closure during engine start,
- reverser deployment authorized: the permission switch supplies the Direction Control Valve (DCV),
- Pressure Raising and Shut-Off Valve (PRSOV) closed: status sent to the ECS Zone Controller (ZC) for bleed air status processing,
- oil low pressure on ground: Avionics Equipment Ventilation Computer (AEVC), Flight Control Data Concentrator (FCDC), Probe Heat Computer (PHC), Window Heat Computer (WHC), Cabin Intercommunication Data System (CIDS), Digital Flight Data Recorder (DFDR), rain repellent, nacelle anti-ice fault-light inhibition, Cockpit Voice Recorder (CVR),
- Throttle Resolver Angle (TRA) in take-off position: signal for ECS pack ram air inlet closure and Cabin Pressure Controller (CPC) pre-pressurization sequence.

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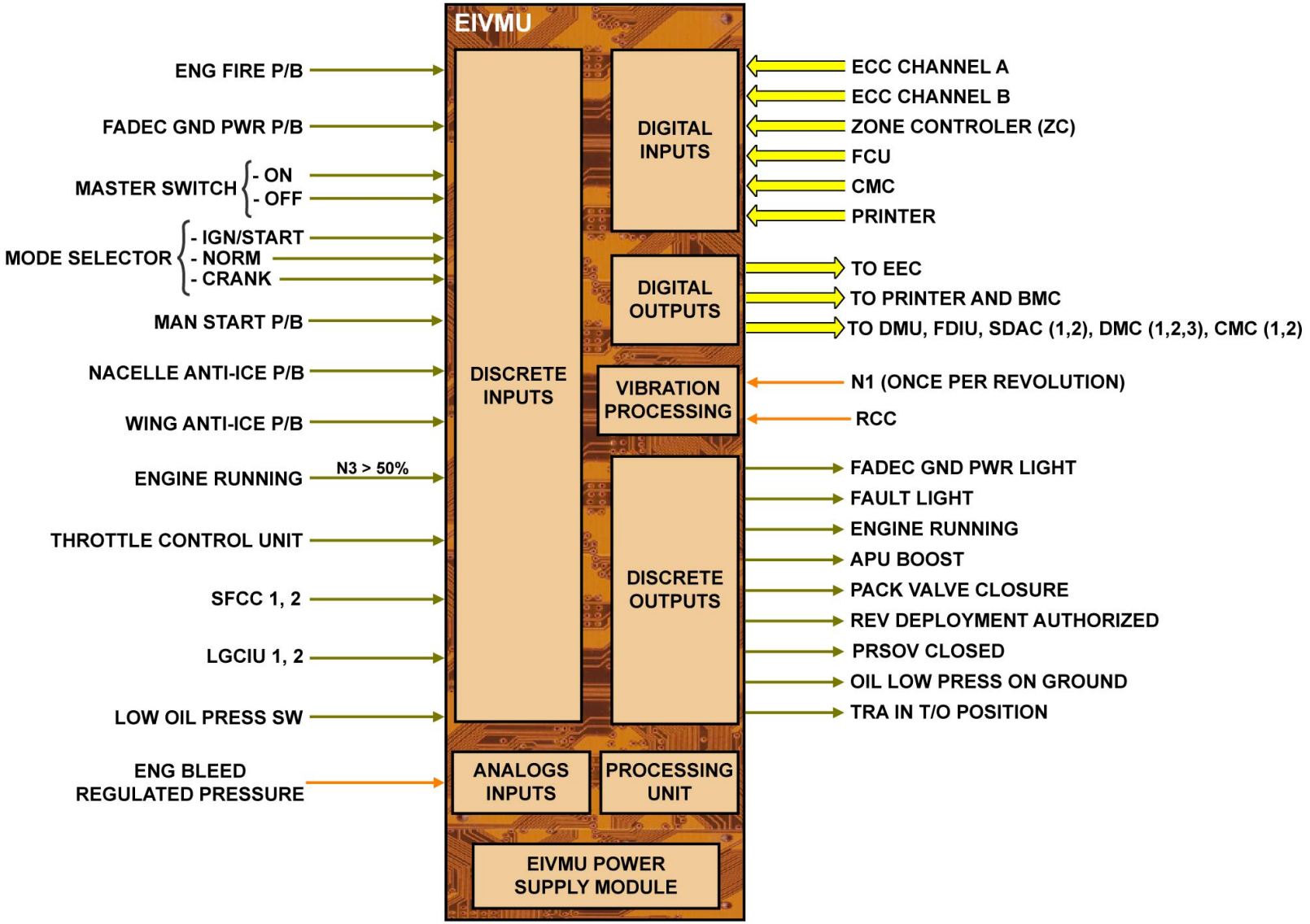

EEC INTERFACES ... OTHER INTERFACES

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EIVMU INTERFACES (3)

CMS INTERFACE

The EEC interfaces with the CMC through the EIVMU for all fault reporting and maintenance operations.

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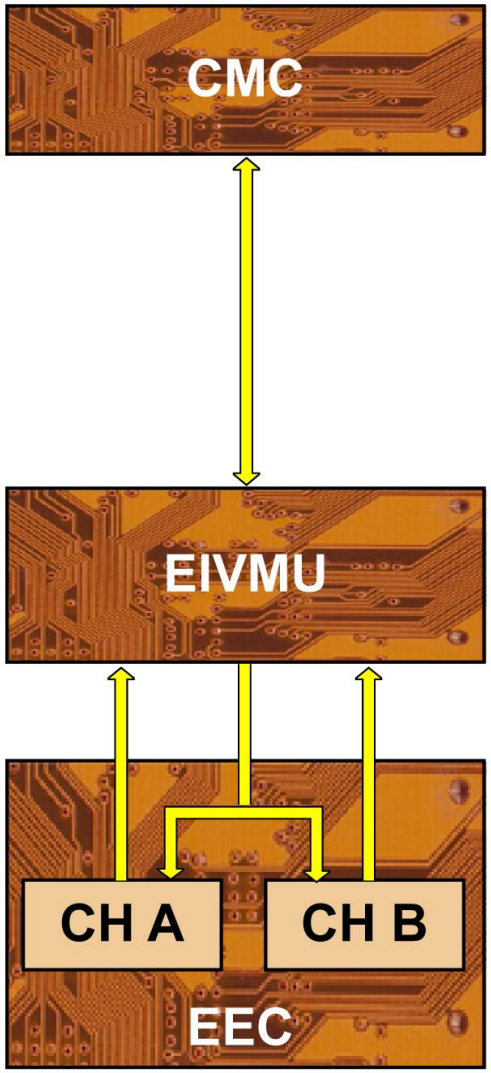

CMS INTERFACE

GCL13151 - G6RT1DU - FM70DI000000071

EIVMU INTERFACES (3)

EIVMU POWER SUPPLY MODULE

The EIVMU power supply module provides 115 VAC from A/C electrical network to the PCU for EEC and ignition system powering. The EIVMU also provides 28 VDC for the thrust reverser DCV. The power supply module is part of the EIVMU box and is still operational even if the EIVMU fails or is not powered; it contains the switching for FADEC powering and de-powering functions.

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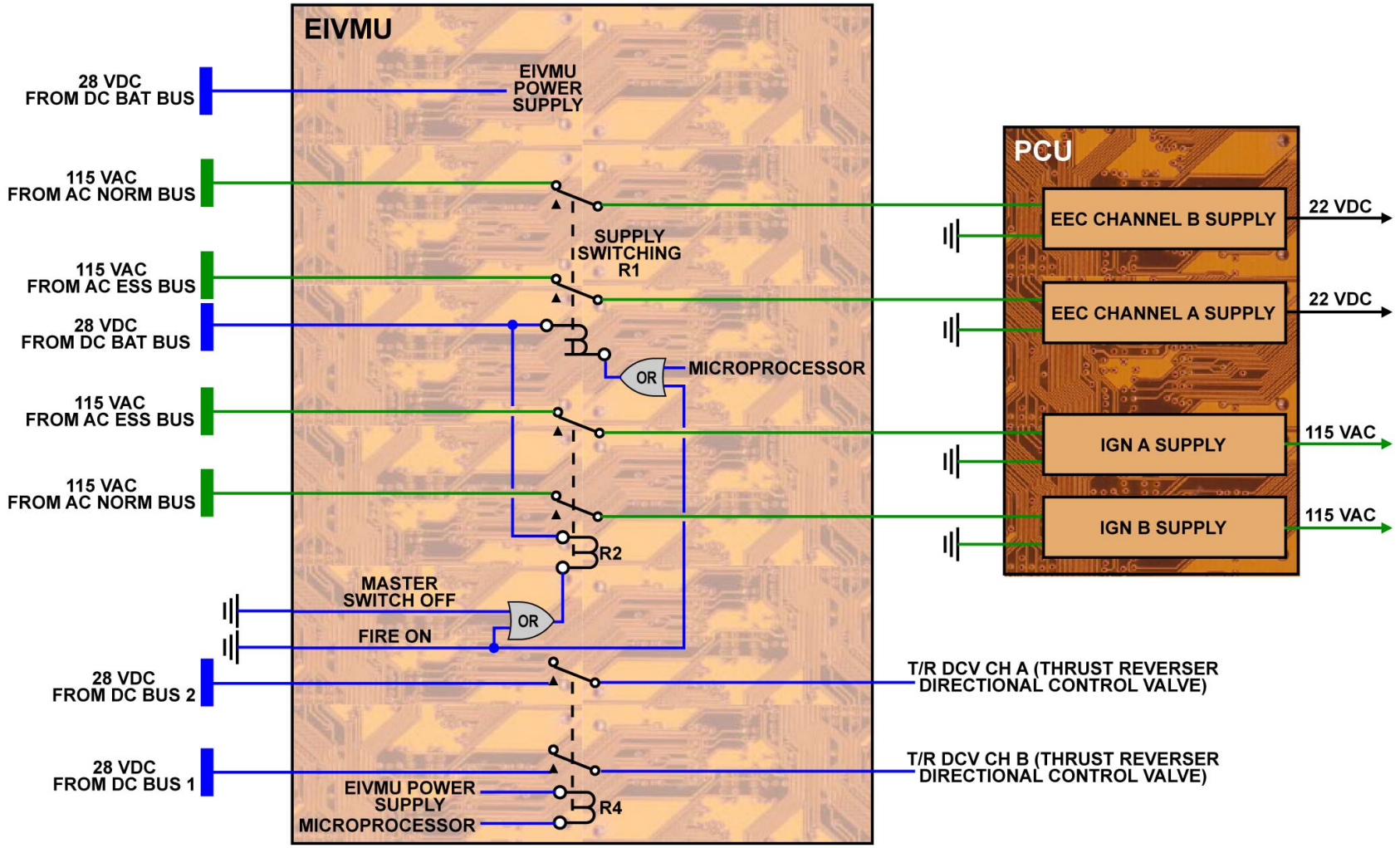

EIVMU POWER SUPPLY MODULE

GCL13151 - G6RT1DU - FM70DI000000071

EIVMU INTERFACES (3)

EIVMU FAILURE

An EIVMU failure is identified by the "ENG 1 (2) EIU FAULT" level 2 ECAM warning. The consequences of this failure are shown in the screen.

GCL13151 - G6RT1DU - FM70DI000000071

IMPACTED SYSTEM OR SUB-SYSTEM	COCKPIT EFFECT	MAINTENANCE IMPACT
	ENG1(2) EIU FAULT T.O THR: TOGA ONLY HI IDLE	A/C DISPATCH ALLOWED WITH ONE EIVMU INOP PROVIDED NO OPERATION IS PREDICTED ON THRUST REVERSER USE
NO WET MOTORING		ONLY DRY MOTORING POSSIBLE
NO EEC INTERROGATION THROUGH MCDU ENG MENU		NO PROMPT AVAILABLE IN FRONT OF EEC 1(2) CHANNEL A AND CHANNEL B
FADEC PERMANENTLY POWERED (RISK OF EEC OVERHEAT)	PERMANENT DISPLAY OF ENG1(2) PRIMARY PARAMETERS	PULL FADEC CHANNEL A AND CHANNEL B C/Bs
AUTO-THRUST INOP	A/THR	
IDLE POWER SET TO "APPROACH IDLE"	ENG1(2) HI IDLE	
NO FLEX T/O, NO DERATED T/O	T.O THR: TOGA ONLY	
NO MANUAL START	ENG1(2) AUTOSTART ONLY	
NO VIBRATION DISPLAY	XX	
THRUST REVERSER INOP	REV 1(2)	NO DEACTIVATION REQUIRED !!
NO PACK RAM AIR INLET CLOSURE + NO LOW FLOW SELECTION AT TOGA	BEFORE T.O PACK 1 OFF PACK 2 OFF BOTH PACKS AVAIL IN FLT	

EIVMU FAILURE

GCL13151 - G6RT1DU - FM70DI000000071

FADEC POWER SUPPLY D/O (3)

GENERAL

The primary source of Engine Electronic Controller (EEC) electrical power when the engine is in operation, is the EEC dedicated alternator. For ground maintenance, engine start or loss of dedicated alternator power, an alternative stand-by power source regulated by the Power Control Unit (PCU) is supplied from the A/C electrical network.

EEC DEDICATED ALTERNATOR

The EEC dedicated alternator has two parts. A rotor with a set of permanent magnets is driven directly by the gearbox. The stator housing is attached to the gearbox case and houses five separate windings.
The dedicated alternator supplies two separate three-phase AC outputs that are converted to DC by the PCU and sent to the EEC, one supply per channel. The dedicated alternator also supplies two separate one-phase power outputs to the Overspeed Protection Unit (OPU). One of these outputs is a spare and could be connected in place of the other winding if it fails.
The dedicated alternator is installed on the forward face of the gearbox. It is also used as the N3 speed sensor and sends N3 signals to both EEC channels.

POWER CONTROL UNIT

The primary function of the PCU is to supply each EEC channel with a stable 22 VDC regulated input. Initial power coming from:
- three-phase supply from the EEC dedicated alternator (during engine operation),
- 115 VAC supply from the A/C electrical buses (during ground maintenance, engine start or failure of the alternator).

Each channel of the dual channel PCU controls the switching of the electrical power source. During engine operation with a fully serviceable alternator, the A/C network power supply is isolated by the PCU.

If a failure of the alternator occurs, the PCU automatically switches to the A/C network power supply.

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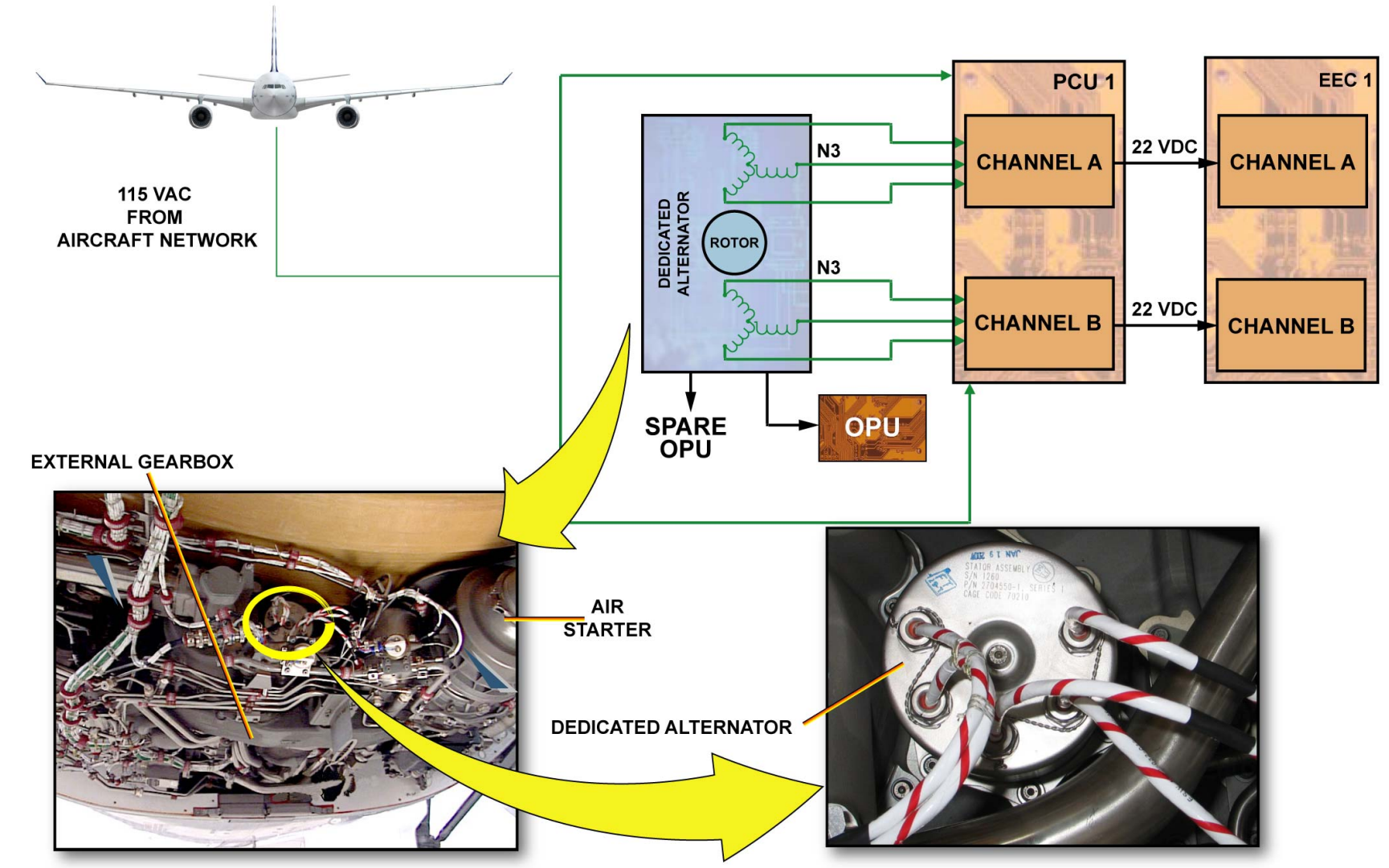
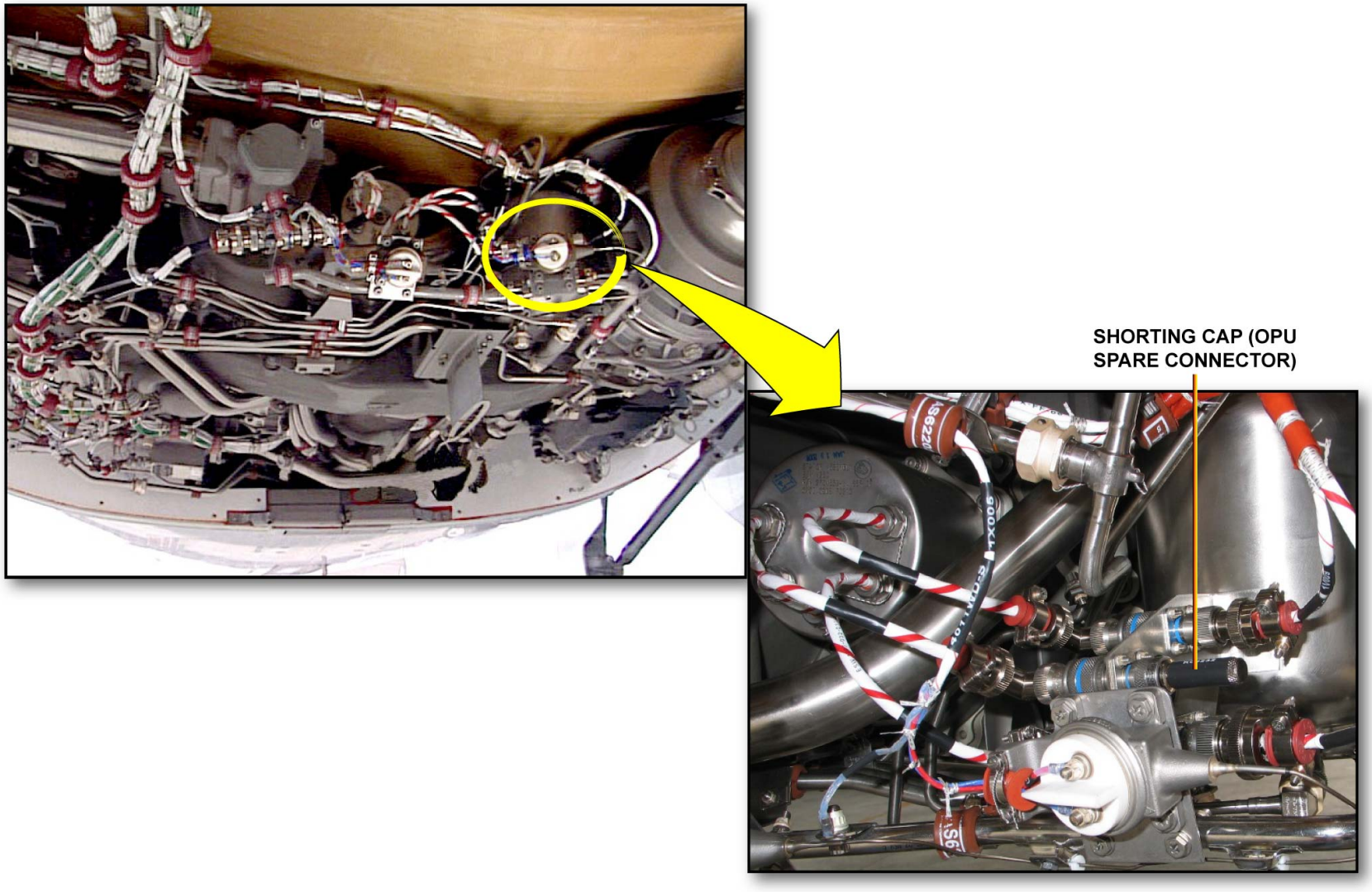


GENERAL ... POWER CONTROL UNIT



GENERAL ... POWER CONTROL UNIT

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FADEC POWER SUPPLY D/O (3)

FADEC POWER SUPPLY SWITCHING BY THE EIVMU

The EIVMU controls the supply of 115 VAC power to the EEC. The control logic is based on the cockpit engine control inputs,

AIRCRAFT POWER-UP

At A/C power-up, both EECs are powered for 15 minutes allowing engine parameters to be checked before starting.

ENGINE MODE SELECTOR

Both EECs are powered as soon as the mode selector is in IGN START or CRANK position. Setting the mode selector back to NORM cancels the power supply to both EECs.

ENGINE MASTER SWITCH

Setting the ENG MASTER switch to ON will power the associated EEC.
Setting the ENG MASTER switch back to OFF will cut off the power to the EEC after 15 minutes.

ENGINE FADEC GROUND POWER

If the ENG FADEC GND PWR switch is selected ON, the associated EEC will be powered for 5 minutes, or will remain powered as long as the interactive FADEC menu is active on MCDU.
If the ENG FADEC GND PWR is deselected, the power to the EEC is immediately cut off.

ENGINE FIRE PUSH-BUTTON

When the ENG FIRE P/B is released out, the A/C 115 VAC power supply to the related FADEC is cut-off by the associated EIVMU.

EIVMU FAILURE

If the EIVMU fails or is de-powered, the associated FADEC remains continuously supplied from the A/C network. Internally, the EIVMU contacts relax and allow 115 VAC power to be supplied to the PCU.

EEC POWERING N3 < 8 %

When N3 speed is below 8%, each EEC channel is independently supplied by the A/C 115 VAC power through its associated Engine Interface and Vibration Monitoring Unit (EIVMU). The 115 VAC is converted into VDC within the PCU and then sent to the EEC. PCU channel A is supplied from the AC ESSENTIAL BUS and PCU channel B from the AC NORMAL BUS.

EEC POWERING N3 > 8 %

As soon as the engine is running above 8% of N3, the dedicated alternator supplies the EEC through the PCU. To make sure that this is the only source used, the A/C 115 VAC power is isolated by the PCU switching control logic.

DEDICATED ALTERNATOR FAILURE

In case of loss of power supply to the EEC channel in control, an EEC channel change over will occur.
If both alternator power supplies are lost, the FADEC will be supplied by the A/C network through the EIVMU.

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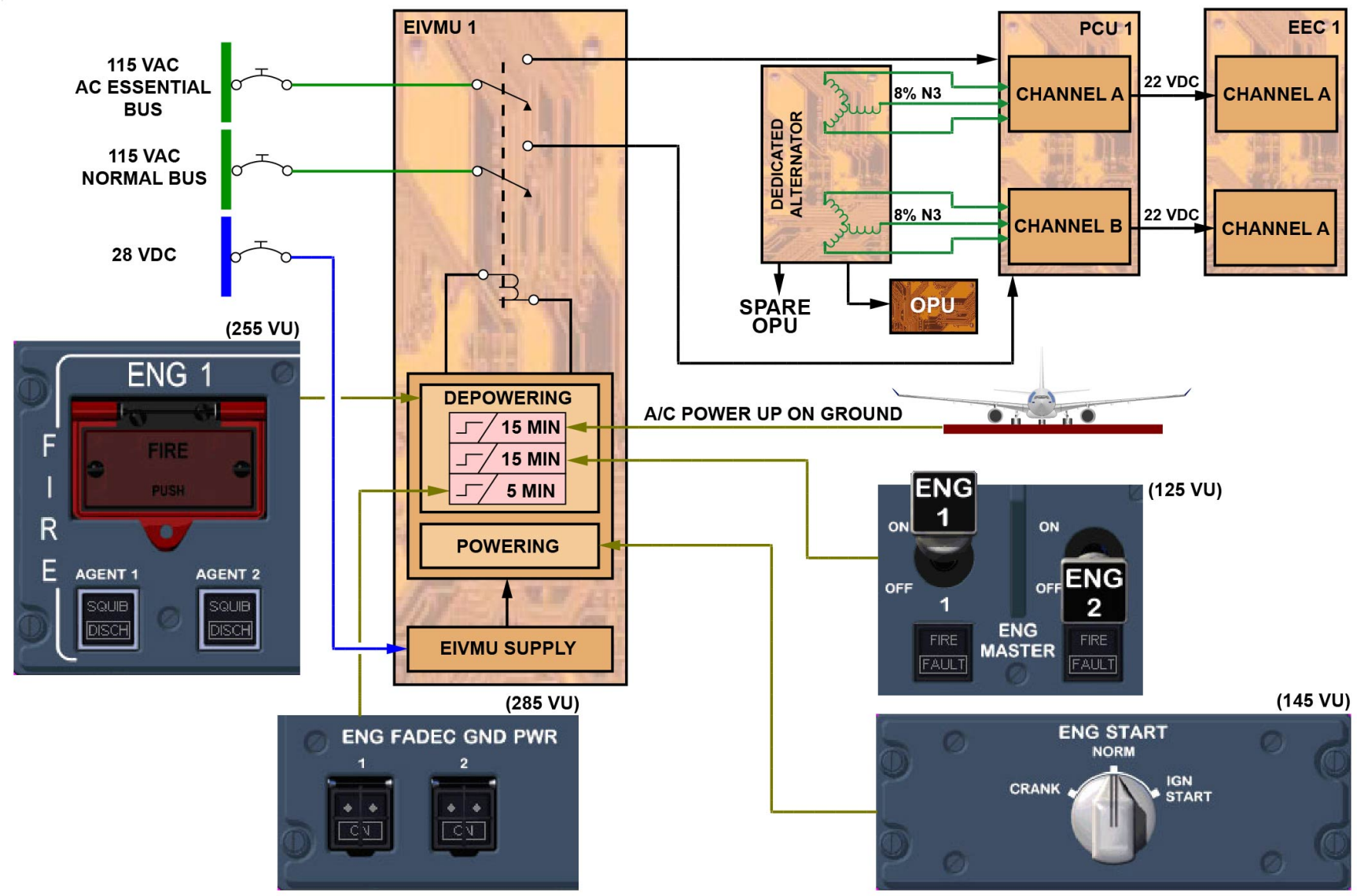


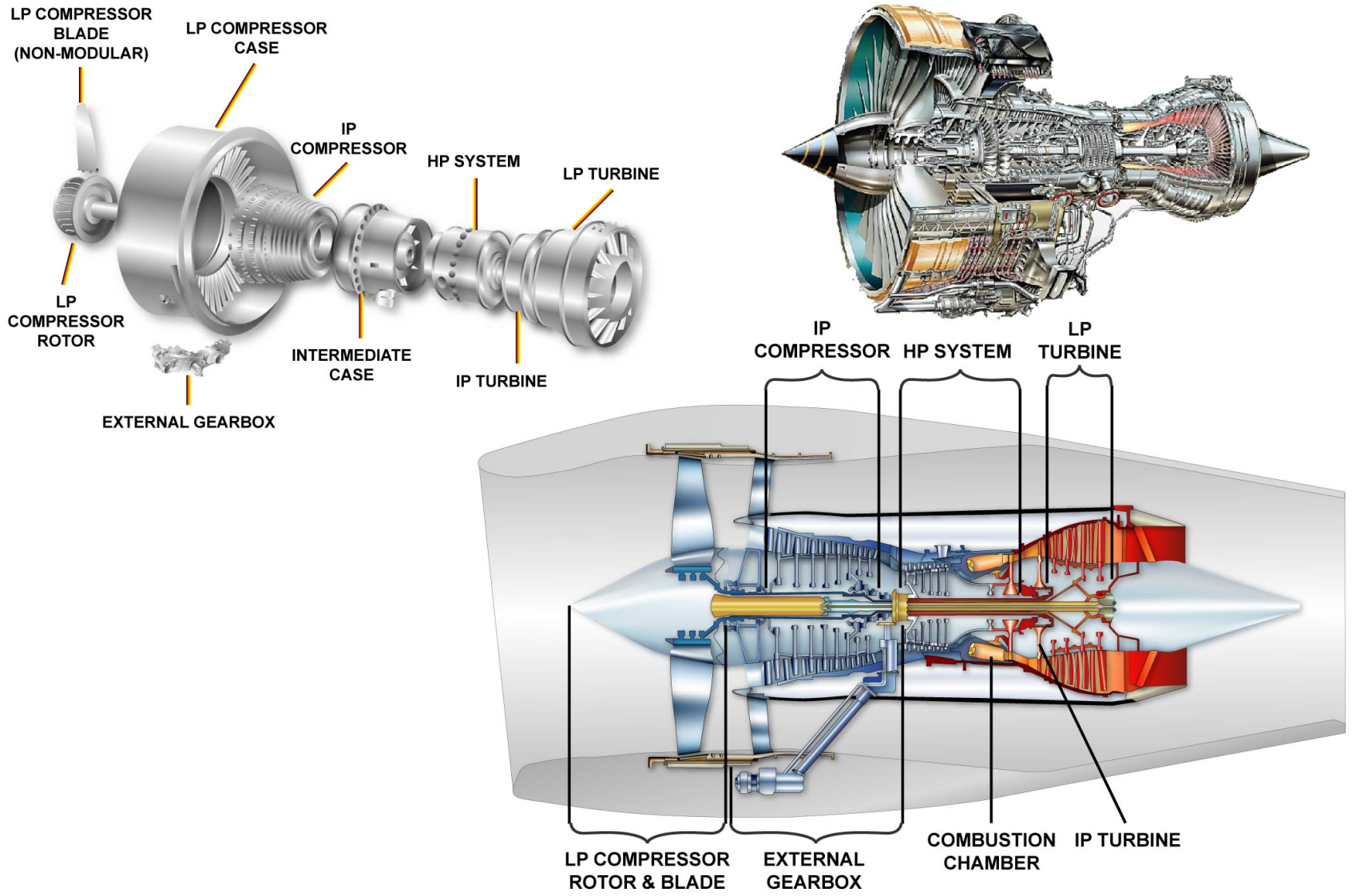
FADEC POWER SUPPLY SWITCHING BY THE EIVMU ... DEDICATED ALTERNATOR FAILURE

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

GENERAL VIEW

The basic engine is an assembly of primary units which are identified as modules.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



GENERAL VIEW

GCL13151 - G6RT1DU - FM70C9COMPLOC71

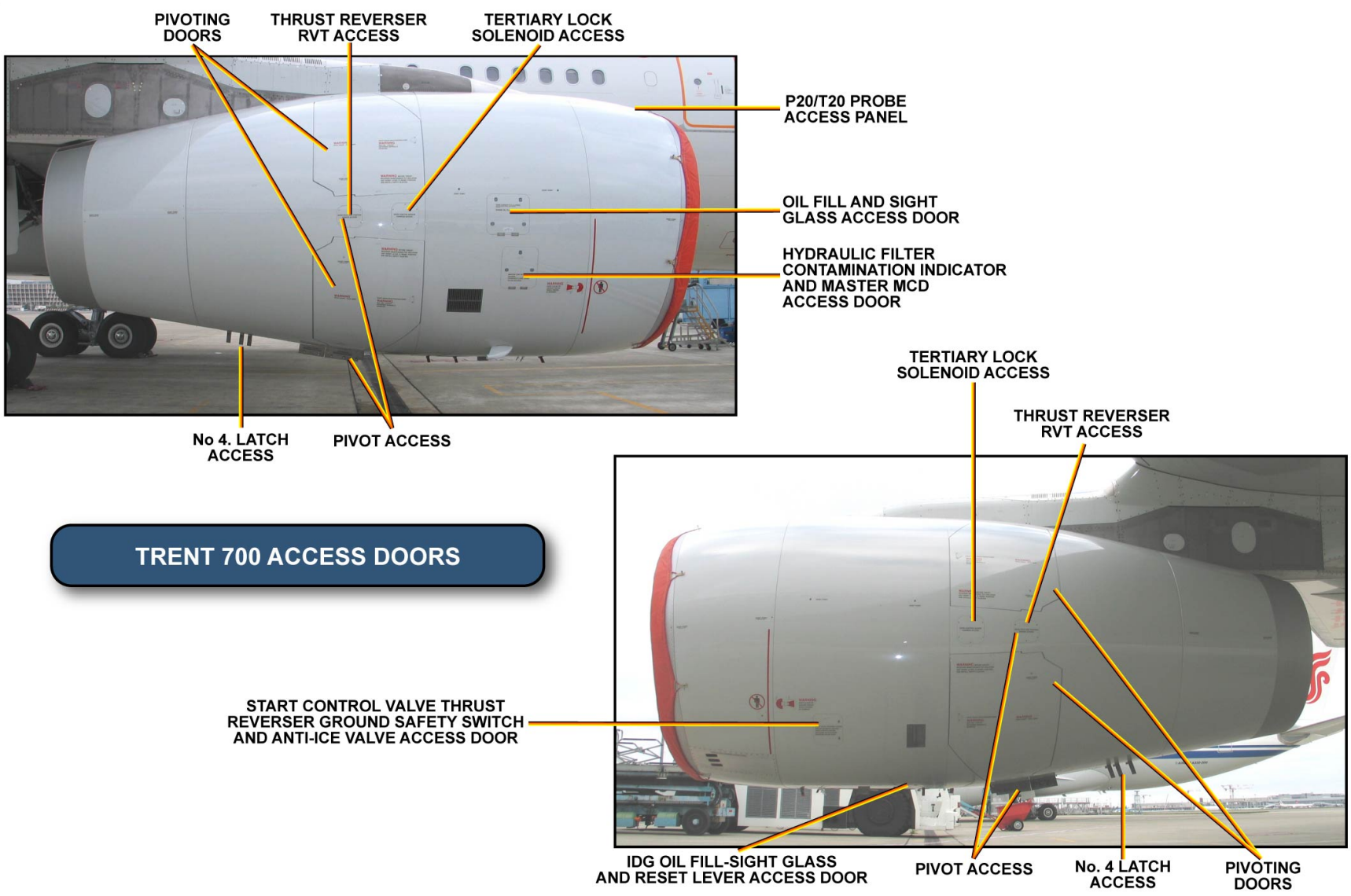
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

NACELLE

The P20/T20 probe access panel is installed at the top of the air intake.
On the left fan cowl, there are:
- Starter control valve, thrust reverser ground safety switch and anti-ice valve access door,
- IDG air cooler outlet,
- IDG oil fill, sight glass and reset lever access door,
- Thrust reverser RVT and Tertiary lock solenoid access doors,

On the right fan cowl, there are:
- Oil fill and sight glass access door,
- Hydraulic filter pop-out indicators and master chip detector door,
- Air/Oil Heat Exchanger (AOHE) outlet,
- Thrust reverser RVT and Tertiary lock solenoid access doors,

GCL13151 - G6RT1DU - FM70C9COMPLOC71


PIVOTING DOORS
THRUST REVERSER RVT ACCESS
TERTIARY LOCK SOLENOID ACCESS
P20/T20 PROBE ACCESS PANEL
OIL FILL AND SIGHT GLASS ACCESS DOOR
HYDRAULIC FILTER CONTAMINATION INDICATOR AND MASTER MCD ACCESS DOOR
No 4. LATCH ACCESS
PIVOT ACCESS
TRENT 700 ACCESS DOORS
TERTIARY LOCK SOLENOID ACCESS
THRUST REVERSER RVT ACCESS
START CONTROL VALVE THRUST REVERSER GROUND SAFETY SWITCH AND ANTI-ICE VALVE ACCESS DOOR
IDG OIL FILL-SIGHT GLASS AND RESET LEVER ACCESS DOOR
PIVOT ACCESS
No. 4 LATCH ACCESS
PIVOTING DOORS

NACELLE

GCL13151 - G6RT1DU - FM70C9COMPLOC71

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

ENGINE

The design of the RR RB-211Trent 772 uses a modular concept. The modules can be replaced independently to decrease the time necessary to return the engine into service. The modules are:
- Module 01: LP compressor rotor,
- Module 02: IP (Intermediate Pressure) compressor,
- Module 03: Intermediate case,
- Module 04: HP system (this includes the HP compressor, the combustion system and the HP turbine),
- Module 05: IP turbine,
- Module 06: External gearbox,
- Module 07: LP compressor case,
- Module 08: LP turbine.

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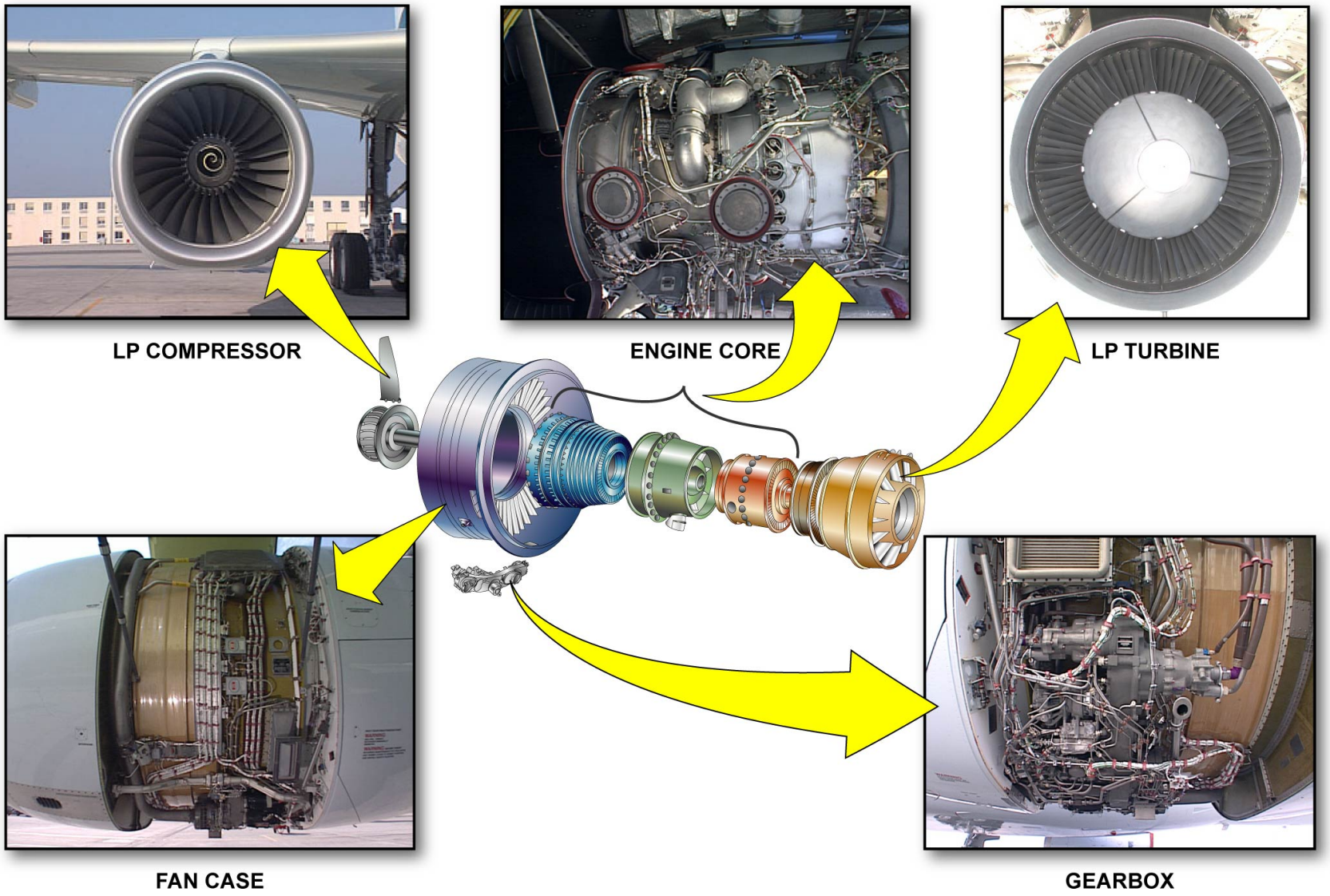


ENGINE

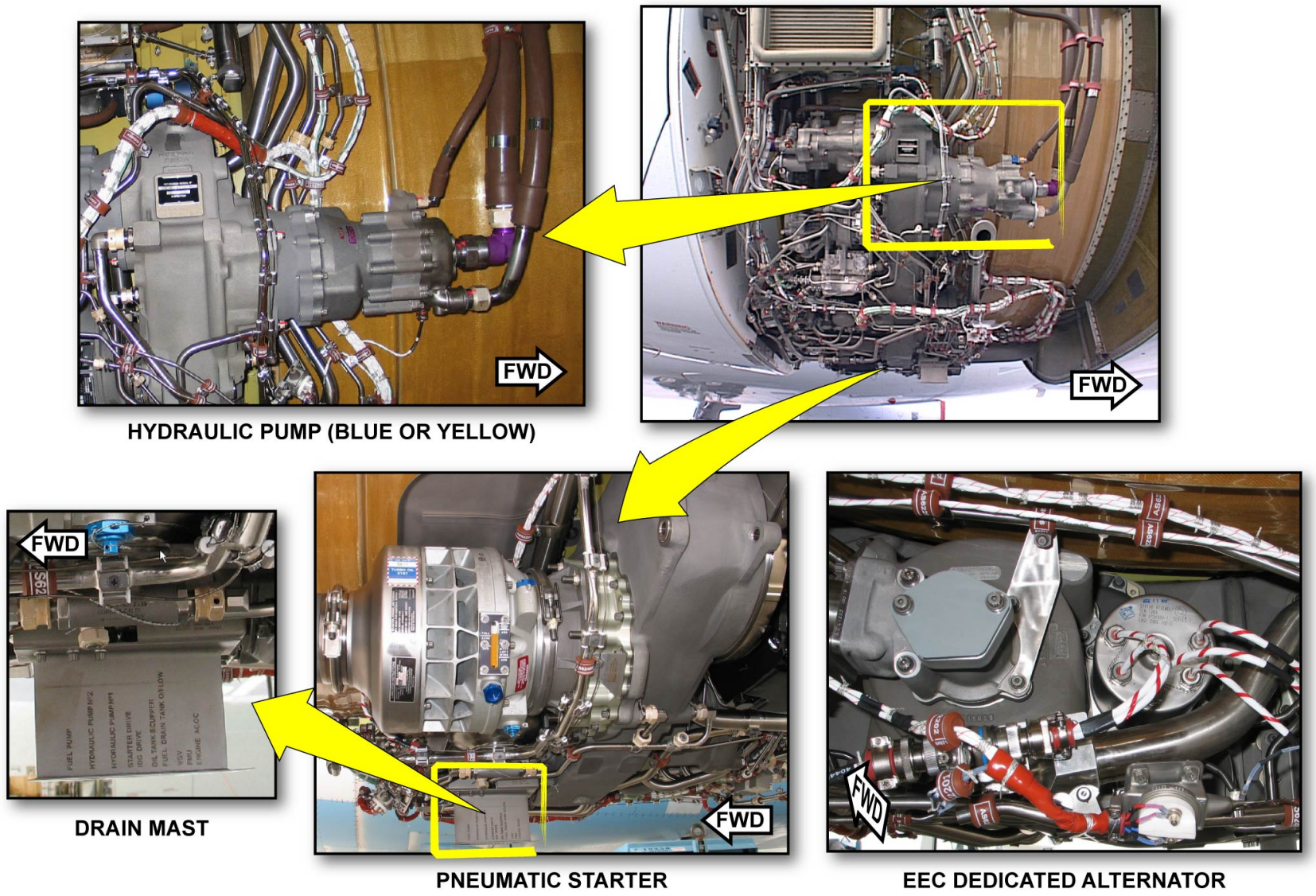
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

GEARBOX

FRONT VIEW

The blue or yellow hydraulic pump, the centrifugal breather, the EEC dedicated alternator and the pneumatic starter are on the front side of the accessory gearbox. The drain mast is below the accessories gearbox.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



GEARBOX - FRONT VIEW

GCL13151 - G6RT1DU - FM70C9COMPLOC71

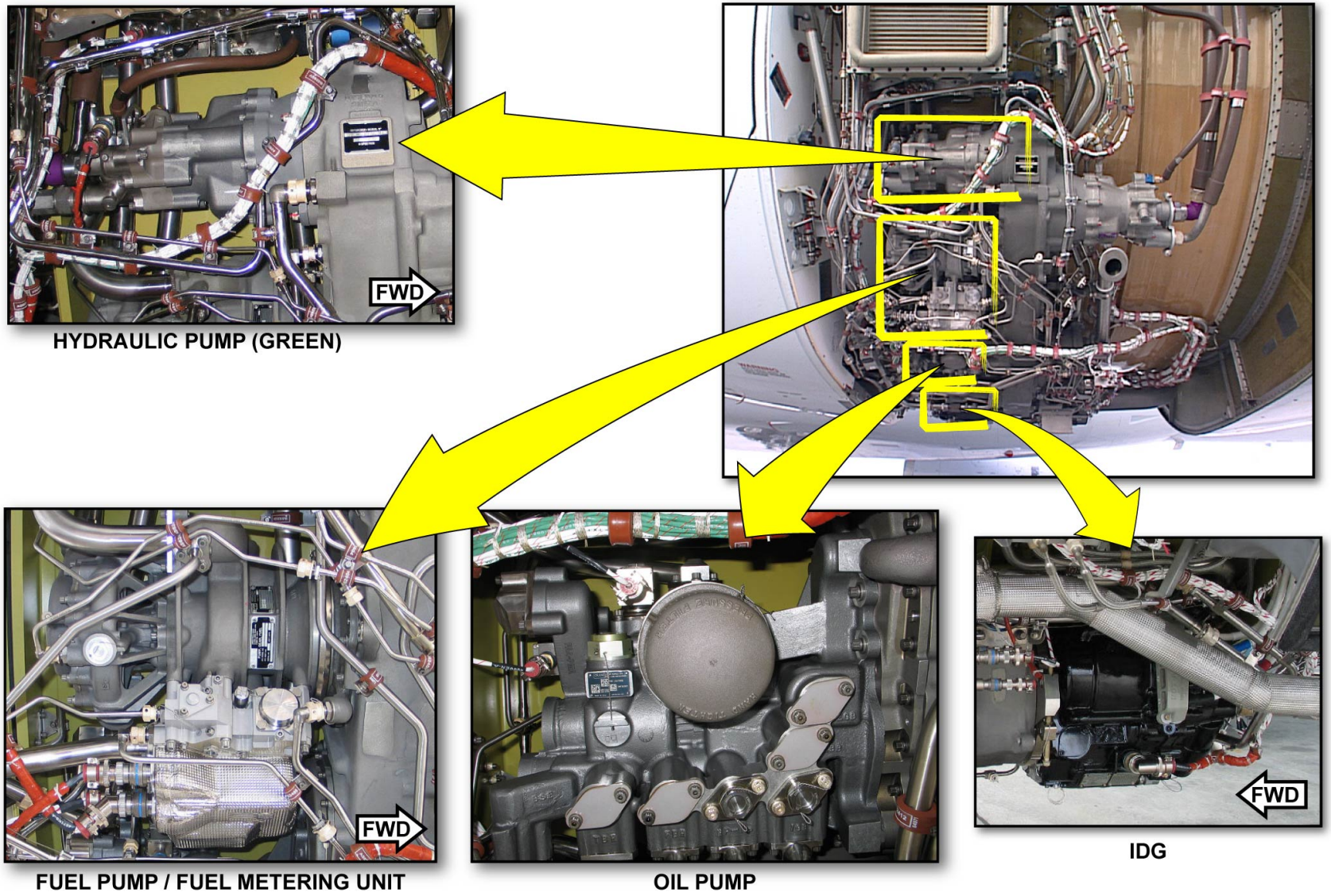
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

GEARBOX (continued)

REAR VIEW

The Integrated Drive Generator (IDG), the oil pump assembly, the fuel pump assembly (with the Fuel Metering Unit (FMU) attached to the pump) and the green hydraulic pump are on the rear side of the accessories gearbox.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



GEARBOX - REAR VIEW

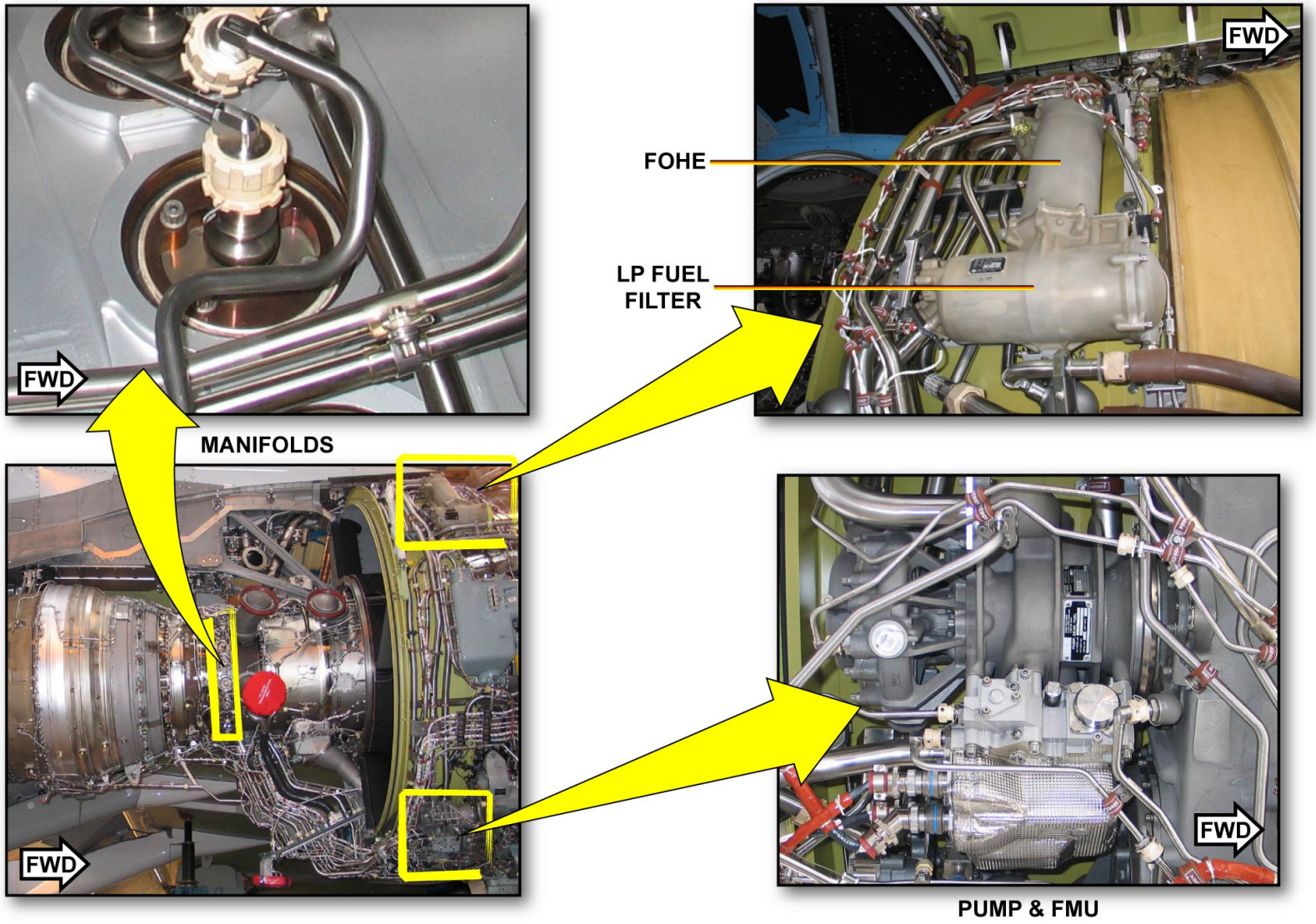
GCL13151 - G6RT1DU - FM70C9COMPLOC71

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

FUEL SYSTEM

The Fuel/Oil Heat Exchanger (FOHE) and the LP fuel filter are on the R/H side of the fan case.
The LP and HP fuel pump and the Fuel Metering Unit (FMU) are on the gearbox.
The primary and secondary fuel manifold and the fuel spray nozzles are on the engine core.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



FUEL SYSTEM

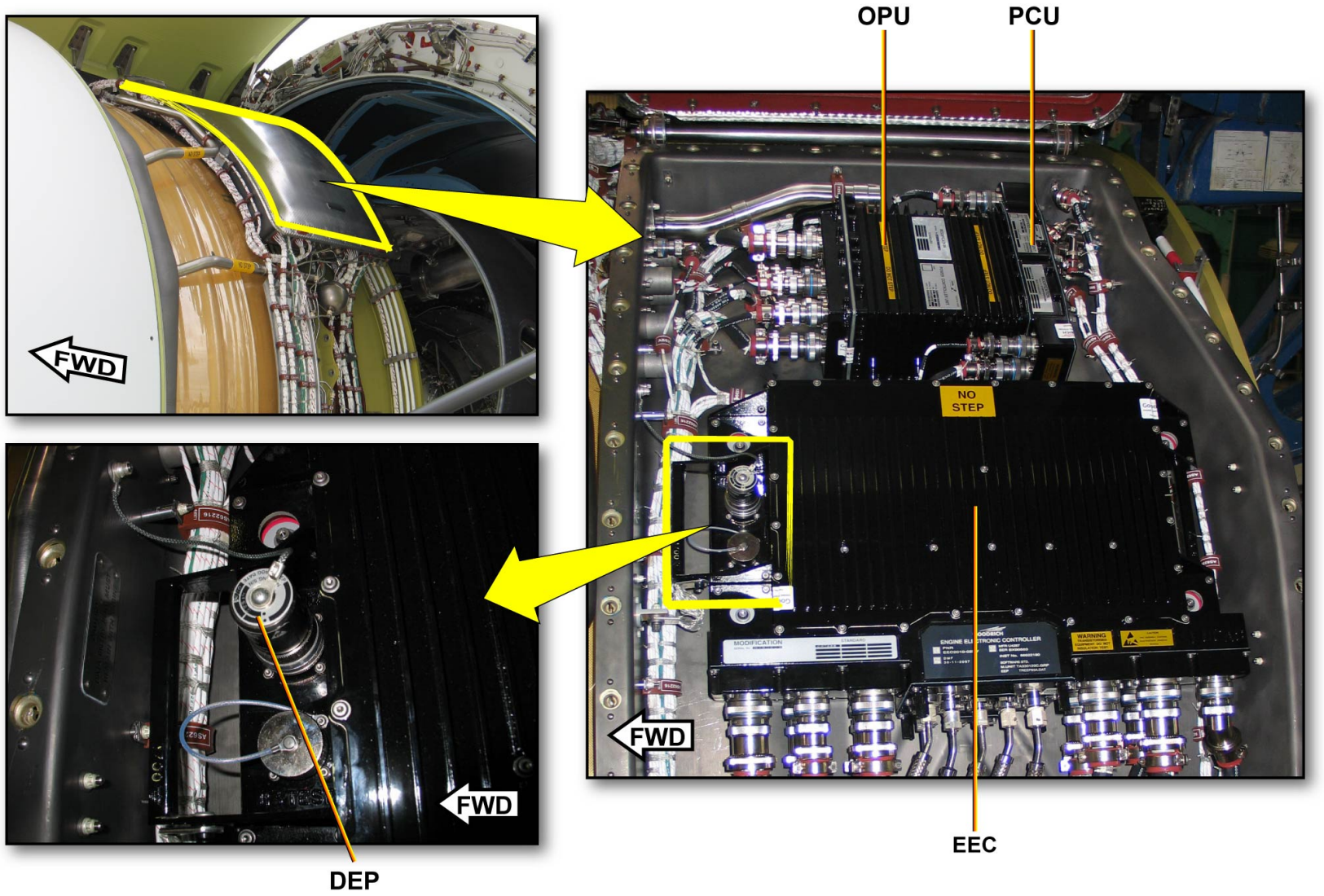
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

FADEC

L/H FAN CASE

The Engine Electronic Controller (EEC), the Data Entry Plug (DEP), the Overspeed Protection Unit (OPU) and the Power Control Unit (PCU) are installed inside the electronic protection box located on the L/H side of the fan case.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



FADEC - L/H FAN CASE

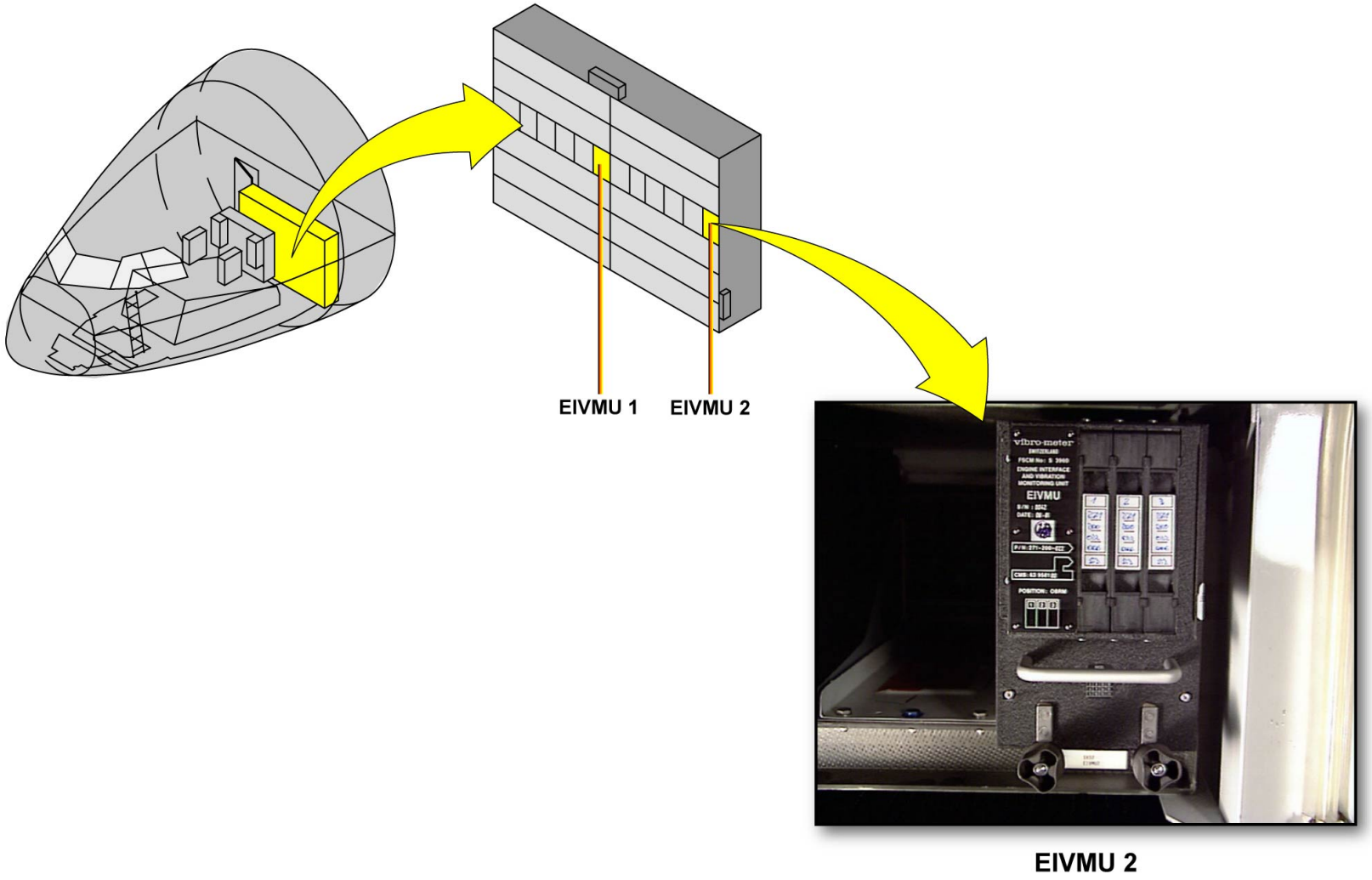
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

FADEC (continued)

AVIONICS BAY

The Engine Interface and Vibration Monitoring Unit (EIVMU) is in the avionics bay.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



EIVMU 2

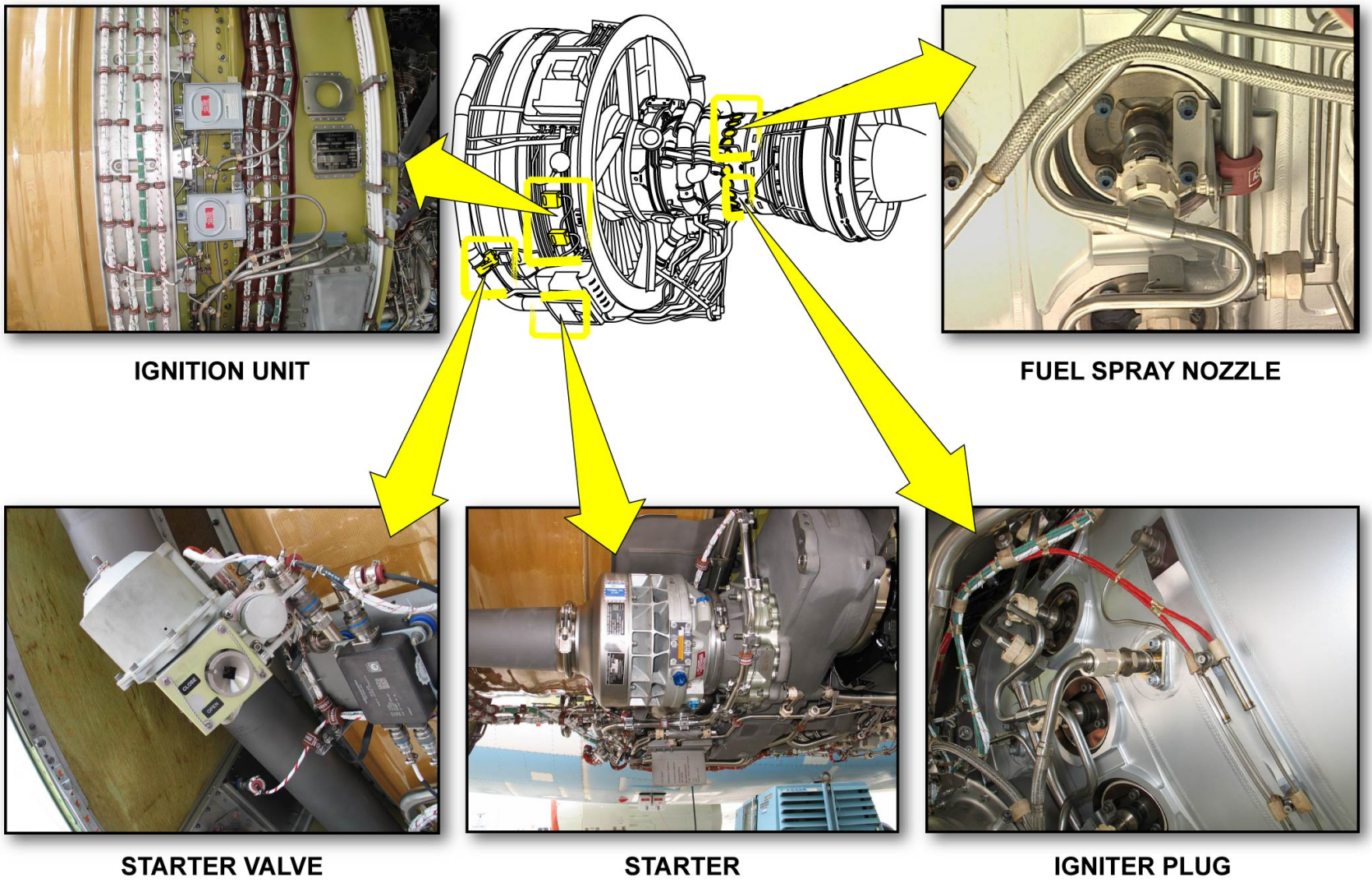
FADEC - AVIONICS BAY

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

IGNITION AND STARTING

The starter control valve and the ignition units A and B are on the L/H side of the fan case.
The pneumatic starter is on the front face of the gearbox.
The igniter plugs are in the engine module 4 (HP system).

GCL13151 - G6RT1DU - FM70C9COMPLOC71



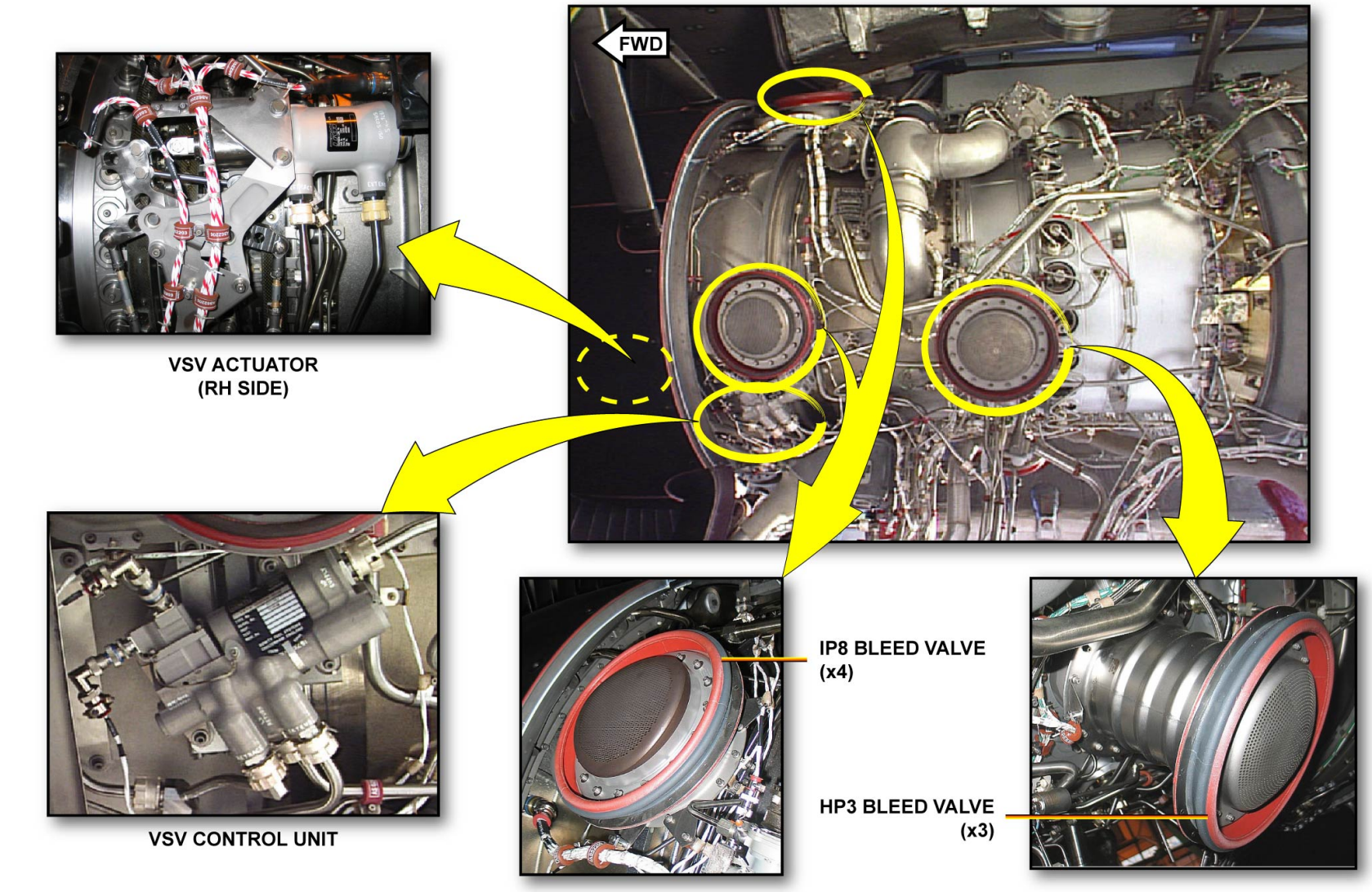
IGNITION AND STARTING

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

AIRFLOW CONTROL SYSTEM

The VSV control unit and the IP8 bleed valves are on the intermediate case (Module 3).
The HP3 bleed valves areI on the HP system (Module 4).

GCL13151 - G6RT1DU - FM70C9COMPLOC71



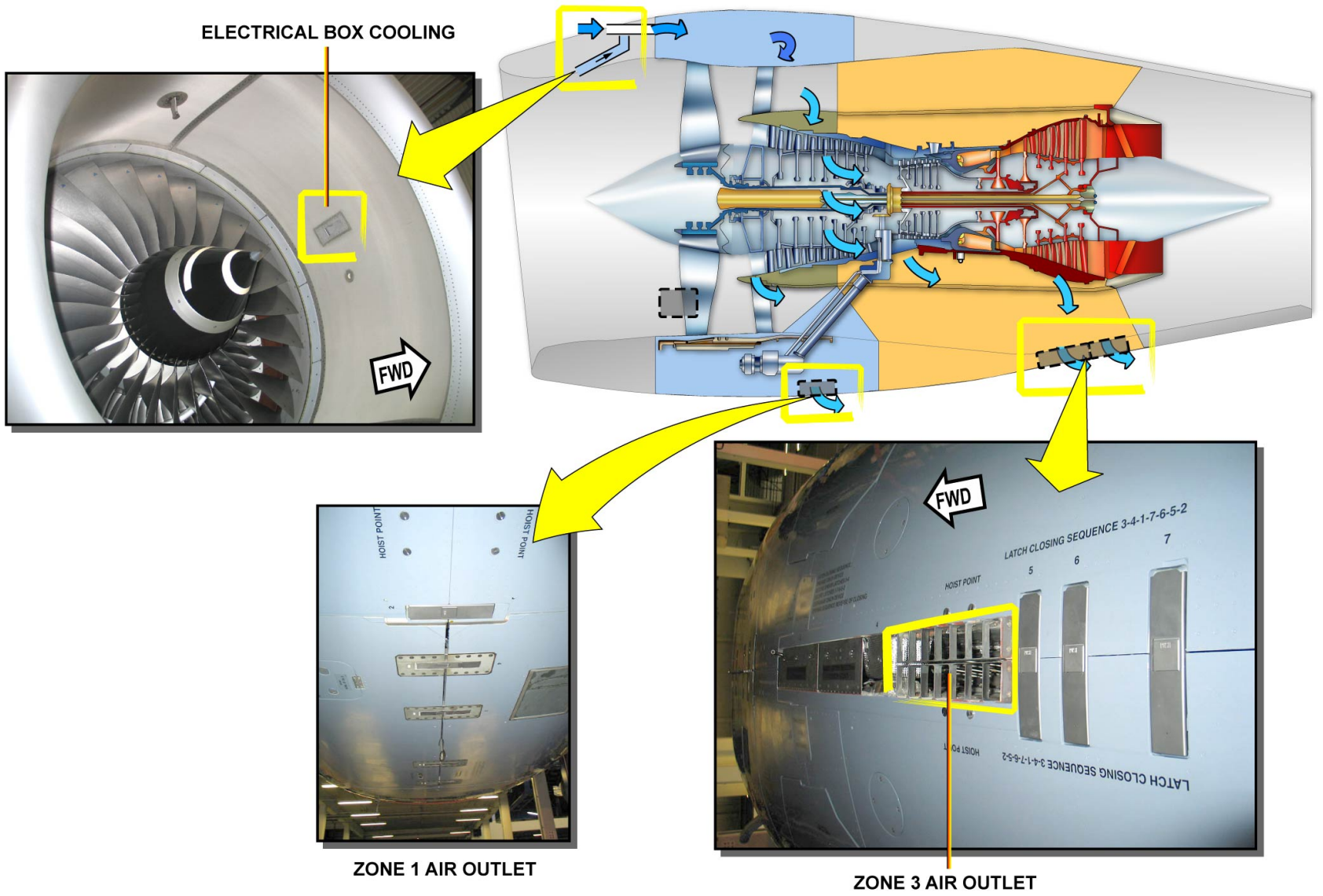
AIRFLOW CONTROL SYSTEM

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

ENGINE COOLING SYSTEM

The Zone 1 cooling air inlet is installed on top of the air inlet cowl. The electronic protection box cooling air inlet and outlet are in the inlet cowl.
The Zone 1 air outlet is at the bottom of the R/H fan cowl.
The Zone 2 air inlet and outlet are on the gas generator fairings of the IP compressor (Module 2).
The Zone 3 air inlet and outlet are on the T/R cowls.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



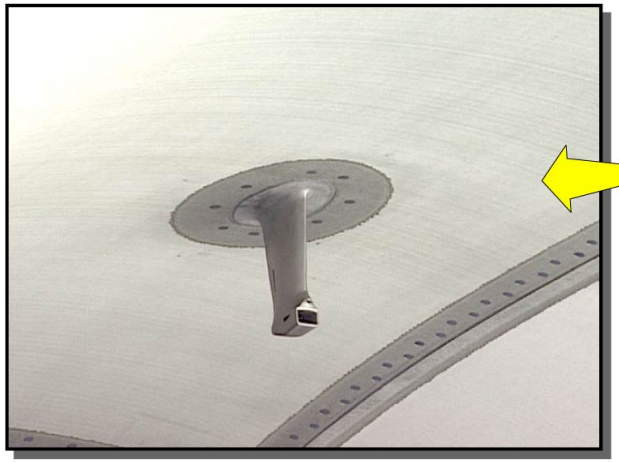
ENGINE COOLING SYSTEM

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

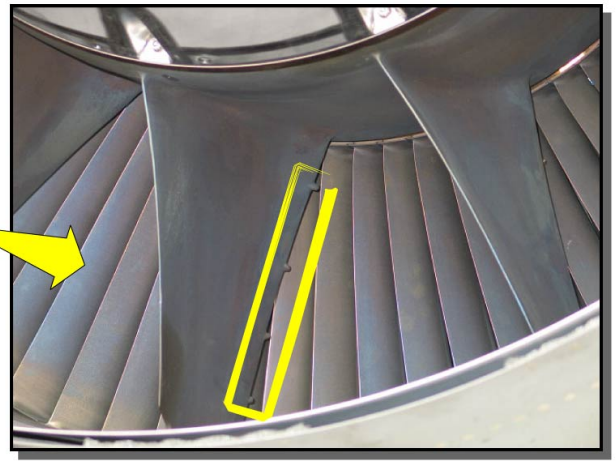
THRUST CONTROL

The P20/T20 probe is in the air intake, at 12 o'clock position.
The P50 pressure tappings are on the LP turbine outlet struts(Module 8)
The Throttle Control Units (TCUs) are in the avionics bay.

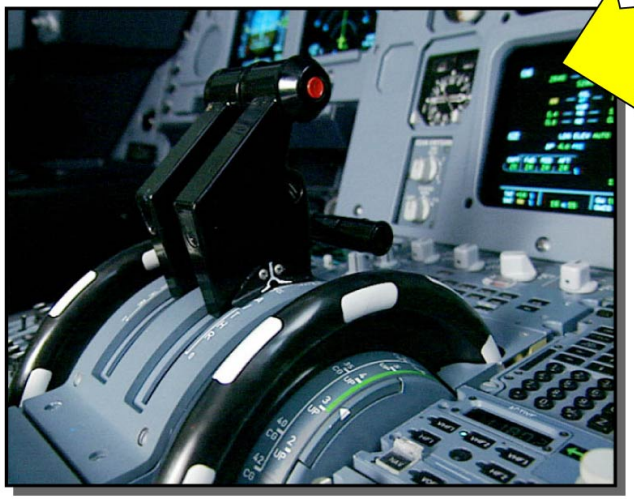
GCL13151 - G6RT1DU - FM70C9COMPLOC71



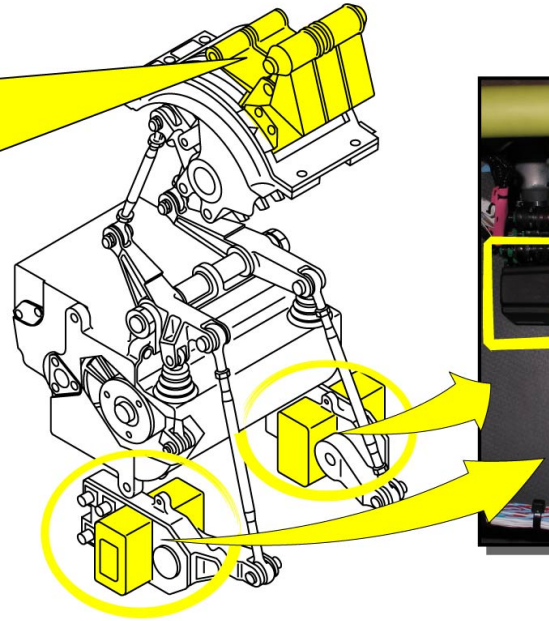
P20 / T20 PROBE

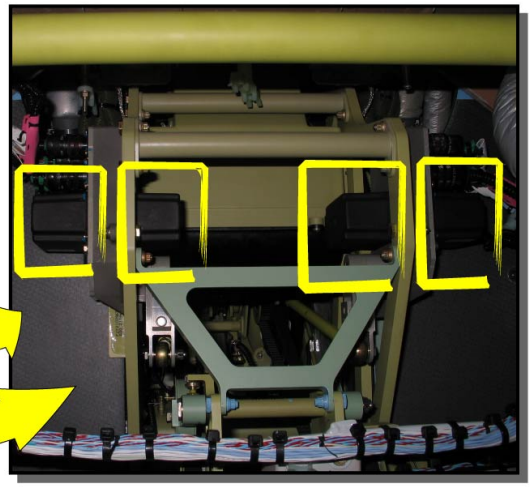


P50 PROBES



THRUST LEVERS





THROTTLE CONTROL UNIT

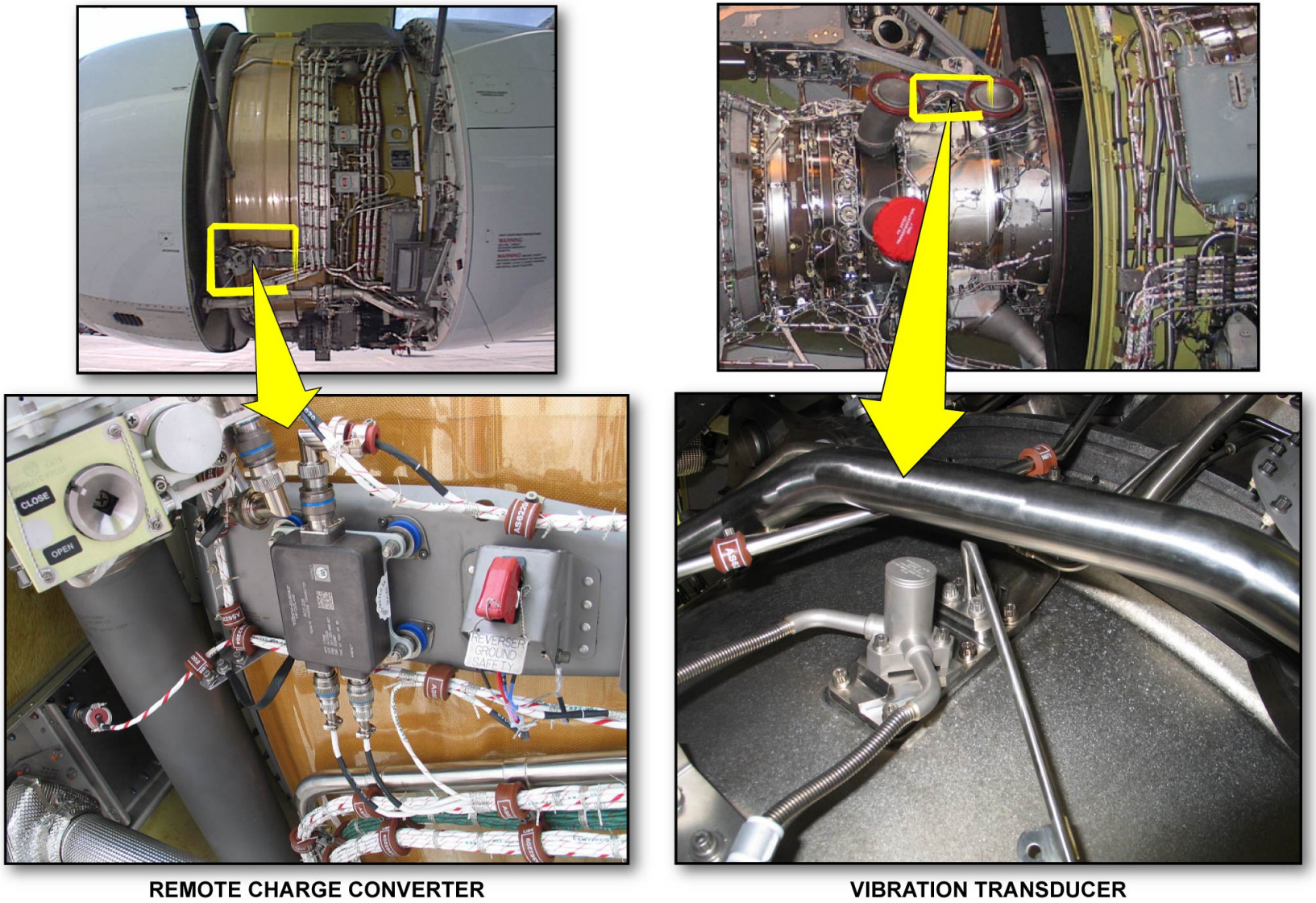
THRUST CONTROL

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

VIBRATION MONITORING SYSTEM

The dual vibration transducer (1 o'clock) is on the intermediate case (Module 3).
The Remote Charge Converter (RCC) is on the L/H fan case, beside the starter control valve.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



REMOTE CHARGE CONVERTER

VIBRATION TRANSDUCER

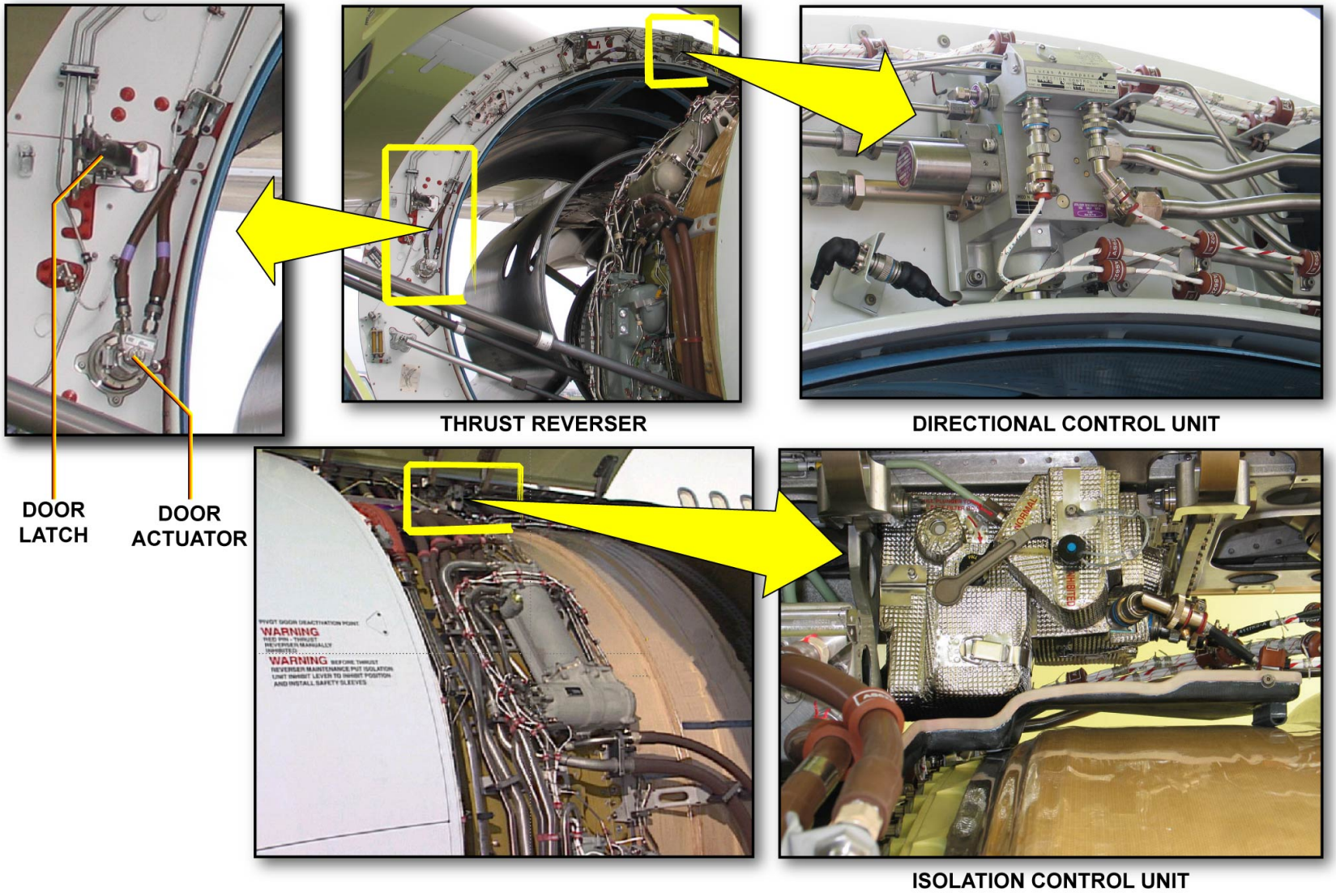
VIBRATION MONITORING SYSTEM

POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

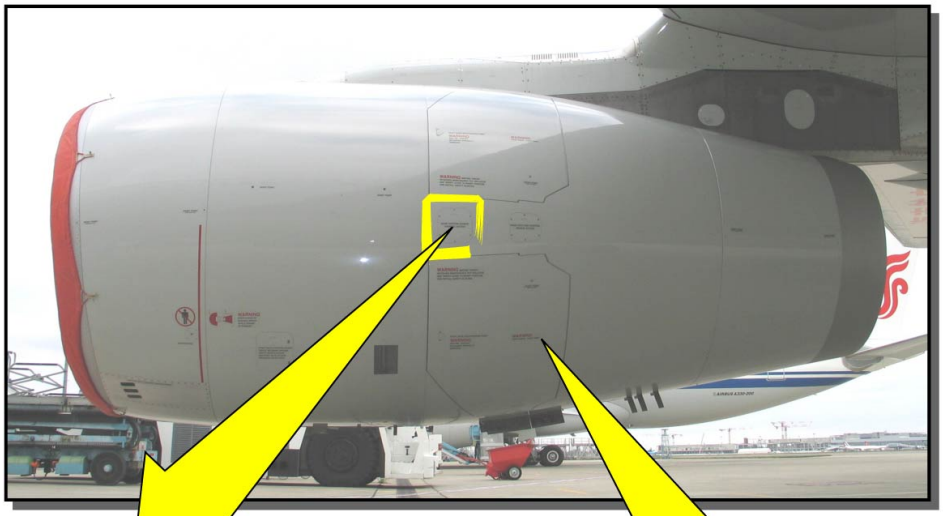
THRUST REVERSER SYSTEM

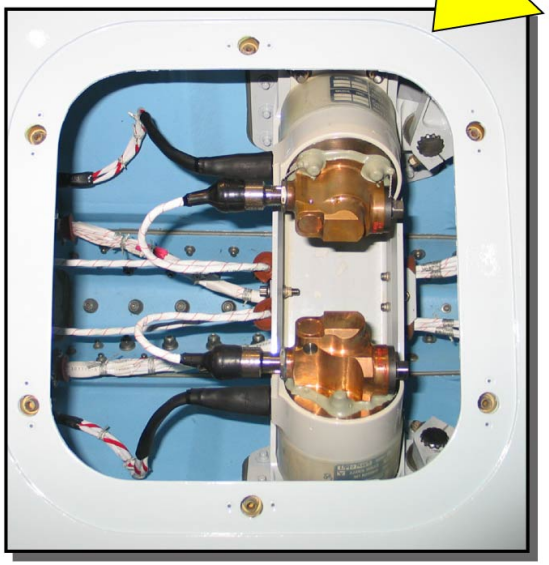
The Isolation Control Unit (ICU) is installed at the top of the R/H fan case.
The Directional Control Unit (DCU) is on the front face of the R/H c-duct.
The pivoting doors actuators and primary locks are attached on the front face of each c-duct.
Two pivoting door are installed on the side of each c-duct. The tertiary locks are accessible through a dedicated access panel located in-between both pivoting doors.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



THRUST REVERSER SYSTEM





TERTIARY LOCKS

PIVOTING DOORS

THRUST REVERSER SYSTEM

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GCL13151 - G6RT1DU - FM70C9COMPLOC71

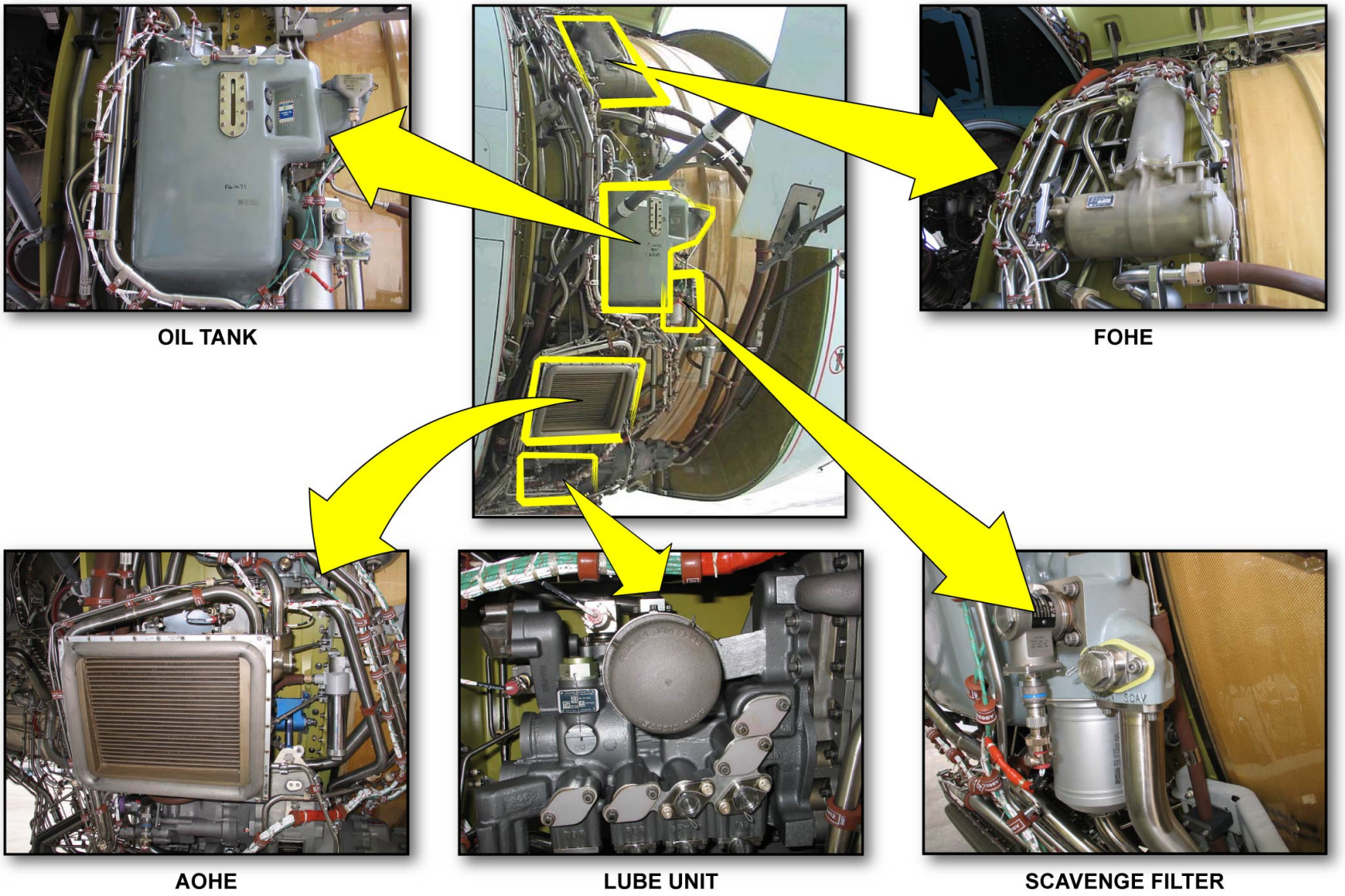
POWER PLANT RR TRENT 700 COMPONENT LOCATION (2)

OIL SYSTEM

The following components are fitted on the R/H fan case:
- Oil tank,
- Master chip detector,
- Scavenge filter,
- Air/Oil Heat Exchanger (AOHE),
- Fuel Oil Heat Exchanger (FOHE).

The lubrication unit is on the rear face of the gearbox.

GCL13151 - G6RT1DU - FM70C9COMPLOC71



OIL SYSTEM

ENGINE SYSTEM CONTROL & INDICATING (2)

LOCATE CONTROL/INDICATING IN COCKPIT

FADEC POWERING

ENGINE START & MOTORING CONTROLS

THRUST CONTROL

ANIMATED SCHEMATIC

GCL13151 - G6RT1DU - FM70IZLEVEL0201

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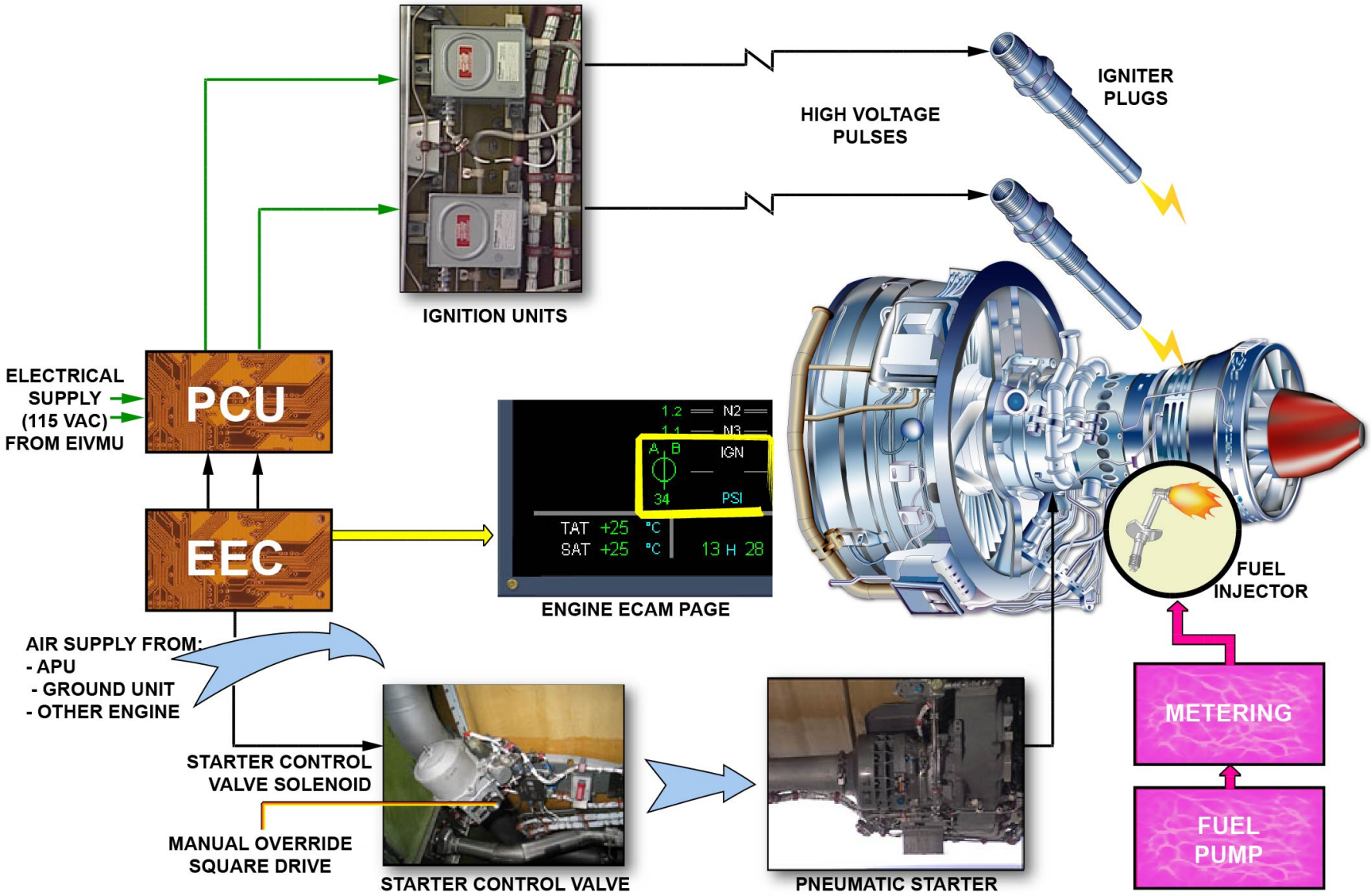
GCL13151 - G6RT1DU - FM70IZLEVEL0201

IGNITION AND STARTING D/O (3)

GENERAL

Engine starting, motoring and ignition sequences are selected by the Engine Electronic Controller (EEC) according to digital command inputs from the Engine Interface and Vibration Monitoring Unit (EIVMU). To achieve these functions, the following sub-systems are combined:
- starting,
- fuel,
- ignition.

GCL13151 - G6RT1DU - FM70DC000000071


IGNITION UNITS
HIGH VOLTAGE PULSES
IGNITER PLUGS
ELECTRICAL SUPPLY (115 VAC) FROM EIVMU
PCU
EEC
ENGINE ECAM PAGE
FUEL INJECTOR
AIR SUPPLY FROM:
- APU
- GROUND UNIT
- OTHER ENGINE
STARTER CONTROL VALVE SOLENOID
MANUAL OVERRIDE SQUARE DRIVE
STARTER CONTROL VALVE
PNEUMATIC STARTER
METERING
FUEL PUMP

GENERAL

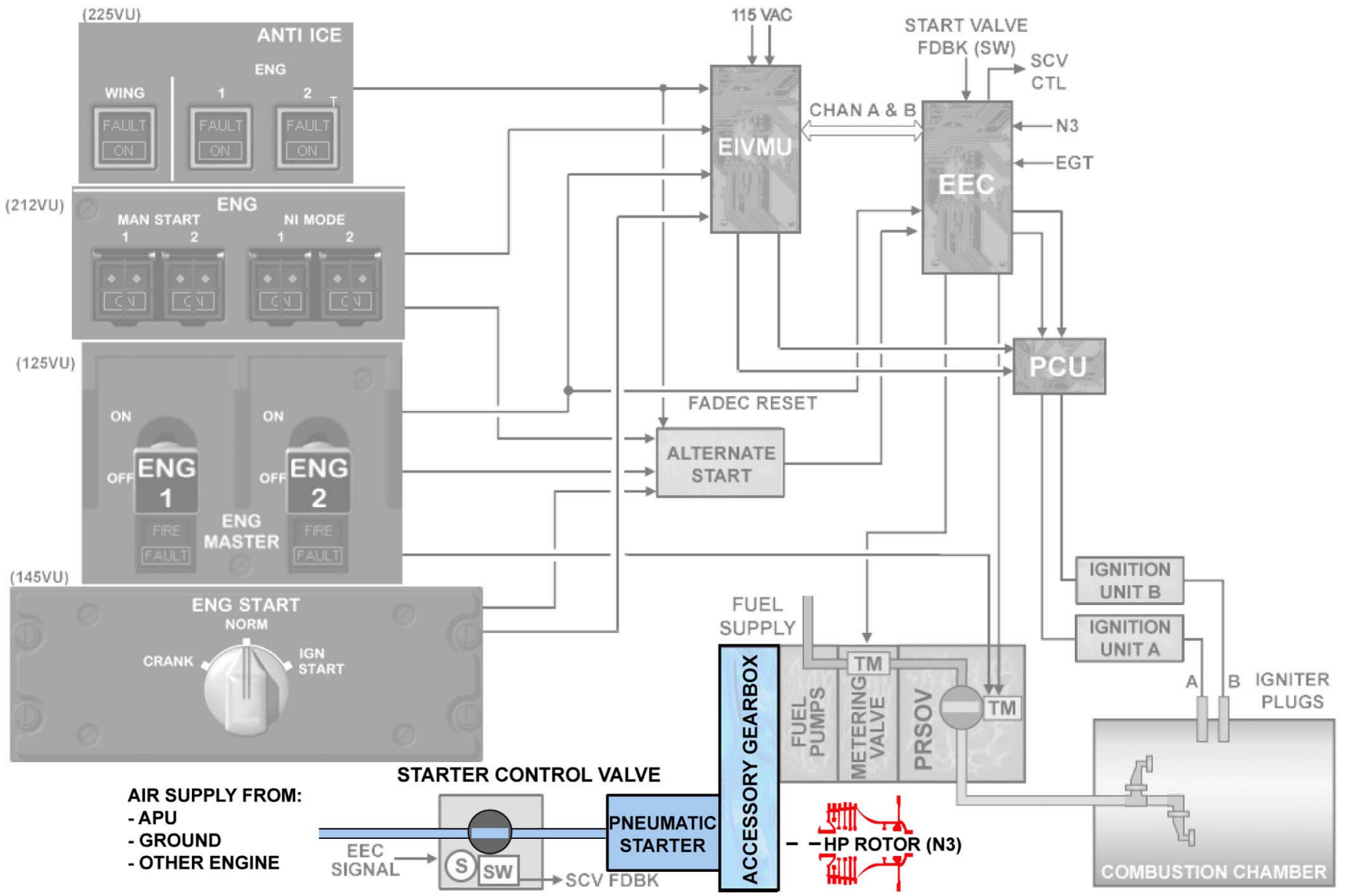
IGNITION AND STARTING D/O (3)

STARTING SYSTEM DESCRIPTION

The primary components of the engine pneumatic starting system are:
- the Starter Control Valve (SCV),
- the pneumatic starter.

The starting system uses air from a ground air supply, the APU or the other engine already started.

GCL13151 - G6RT1DU - FM70DC000000071



STARTING SYSTEM DESCRIPTION

IGNITION AND STARTING D/O (3)

STARTING SYSTEM DESCRIPTION (continued)

PNEUMATIC STARTER

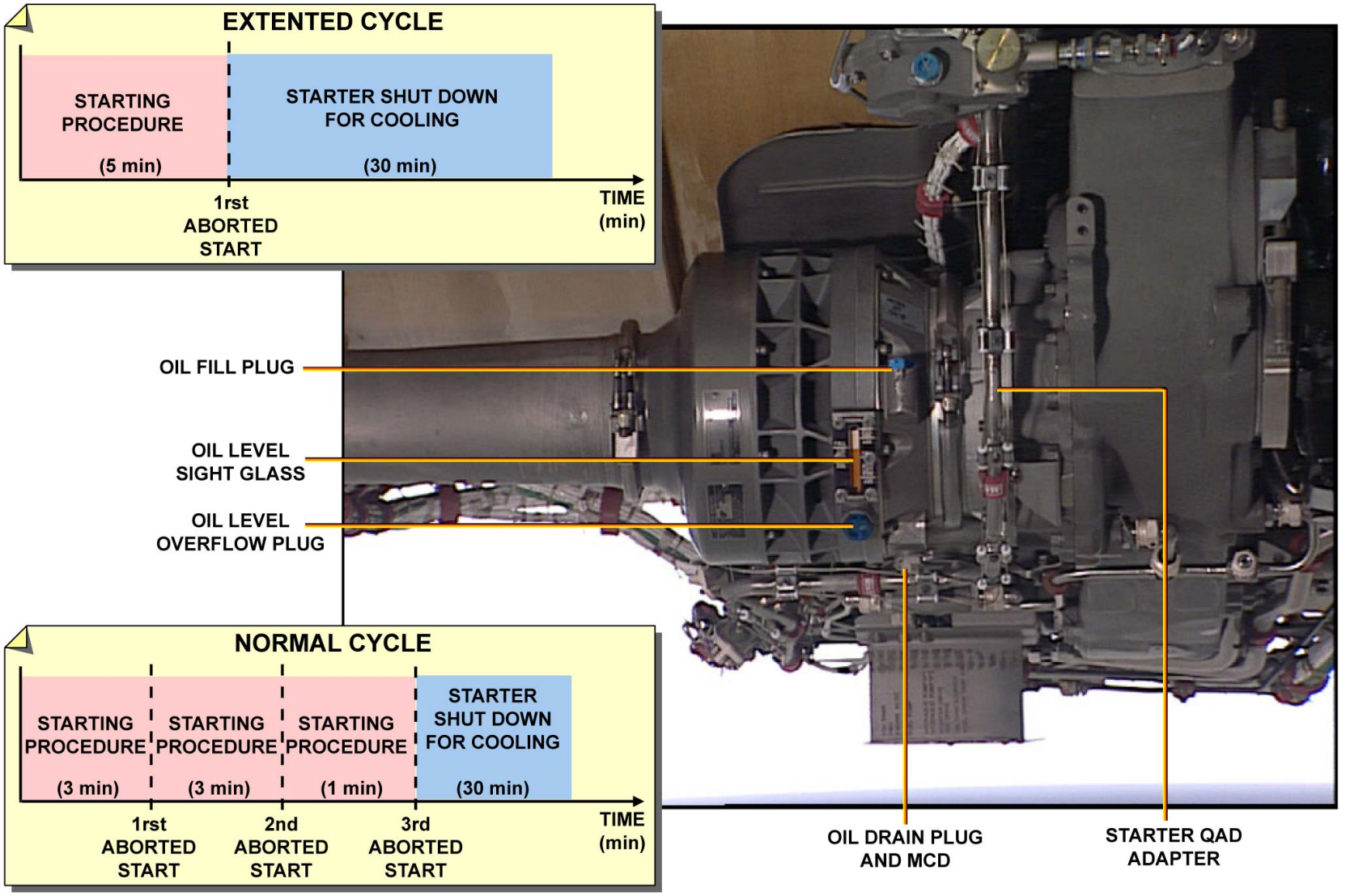
The pneumatic starter is a pneumatically operated turbine installed on the gearbox by a Quick Attach Detach (QAD) adapter. The starter rotates the HP rotor (N3) through an external gearbox module input shaft.

An oil fill plug and an oil level overflow plug are installed on the starter case. An oil level sight glass is also installed on the starter case for oil level indication.

A drain plug with a Magnetic Chip Detector (MCD) is installed on the starter case lower surface.

The continuous operation of the pneumatic starter must be limited in accordance with the limits outlined in the AMM.

GCL13151 - G6RT1DU - FM70DC000000071



STARTING SYSTEM DESCRIPTION - PNEUMATIC STARTER

IGNITION AND STARTING D/O (3)

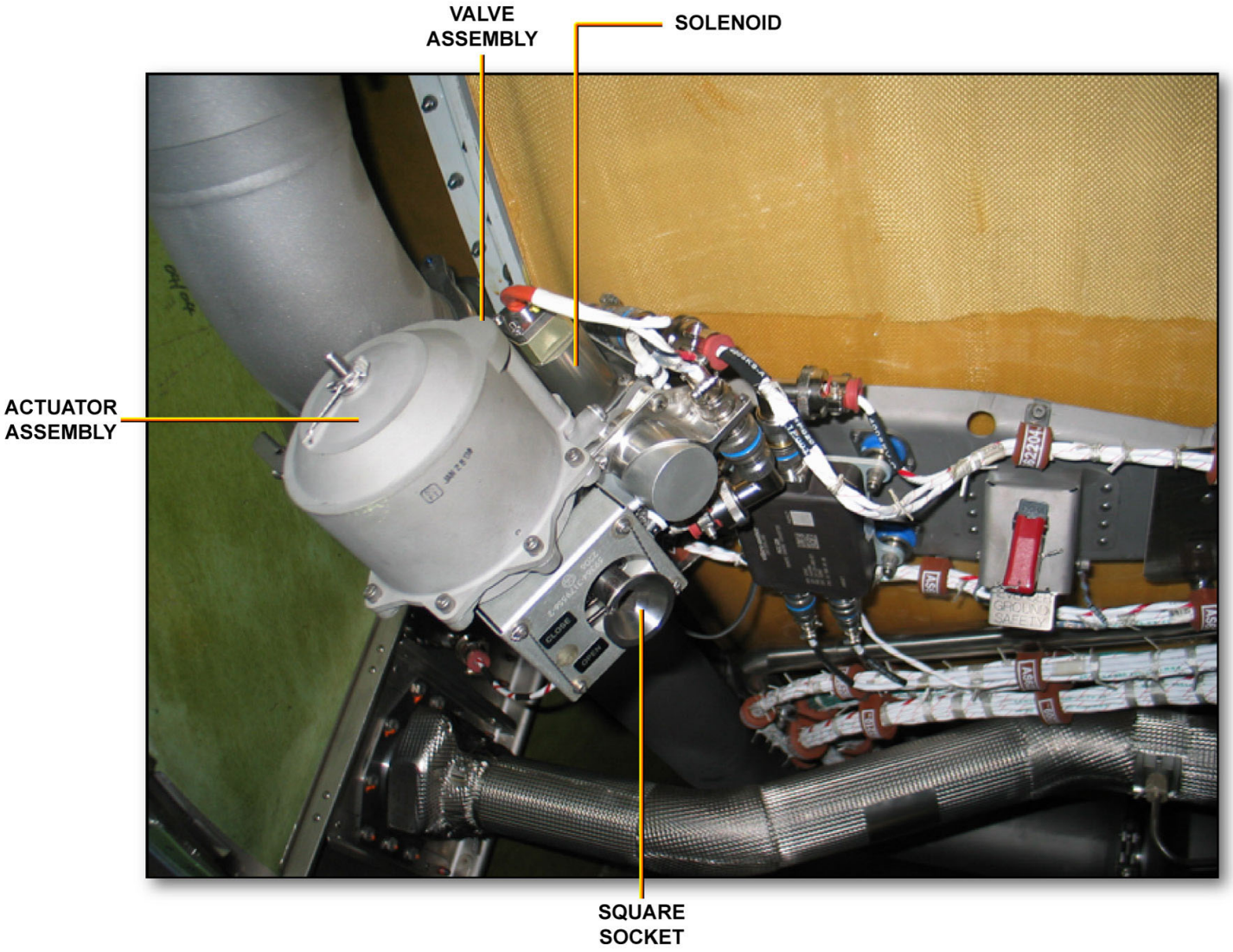
STARTING SYSTEM DESCRIPTION (continued)

STARTER CONTROL VALVE (SCV)

The Starter Control Valve (SCV) controls the airflow delivered to the pneumatic starter. The SCV is located on the lower LH side of the LP compressor case. The SCV is electrically controlled and monitored by the EEC and is pneumatically operated.
The primary components of the SCV are:
- a valve assembly which has a butterfly valve,
- an actuator assembly that transmits the movement to open and close the butterfly valve,
- a dual coil solenoid, controlled by electrical signals from the EEC.

The SCV has a square socket to get manual operation of the butterfly valve in case of SCV electrical control failure. It is accessible through an access door located on the left fan cowl door (it is not necessary to open the fan cowl doors). The valve position is given to the EEC by two microswitches, one for each EEC channel.

GCL13151 - G6RT1DU - FM70DC000000071



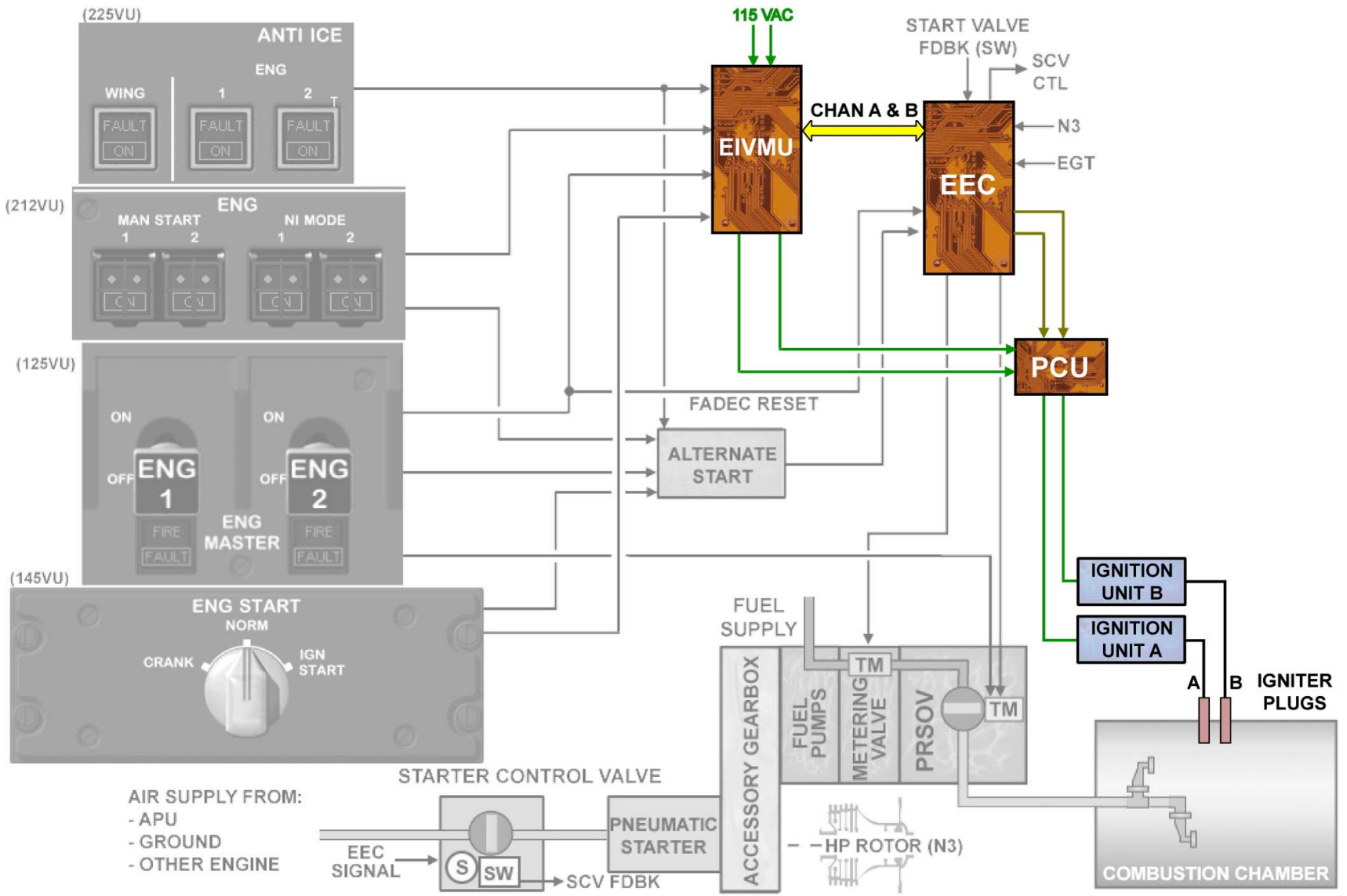
STARTING SYSTEM DESCRIPTION - STARTER CONTROL VALVE (SCV)

IGNITION AND STARTING D/O (3)

IGNITION SYSTEM DESCRIPTION

Each engine has two ignition systems, A and B. These systems are controlled by the EEC and can be operated independently or simultaneously. Each system has an ignition unit, an ignition lead and an igniter plug. Each ignition system is electrically supplied with a dedicated 115 VAC power line delivered by the aircraft electrical system through the EIVMU and transmitted to the Power Control Unit (PCU).

GCL13151 - G6RT1DU - FM70DC000000071



IGNITION SYSTEM DESCRIPTION

IGNITION AND STARTING D/O (3)

IGNITION SYSTEM DESCRIPTION (continued)

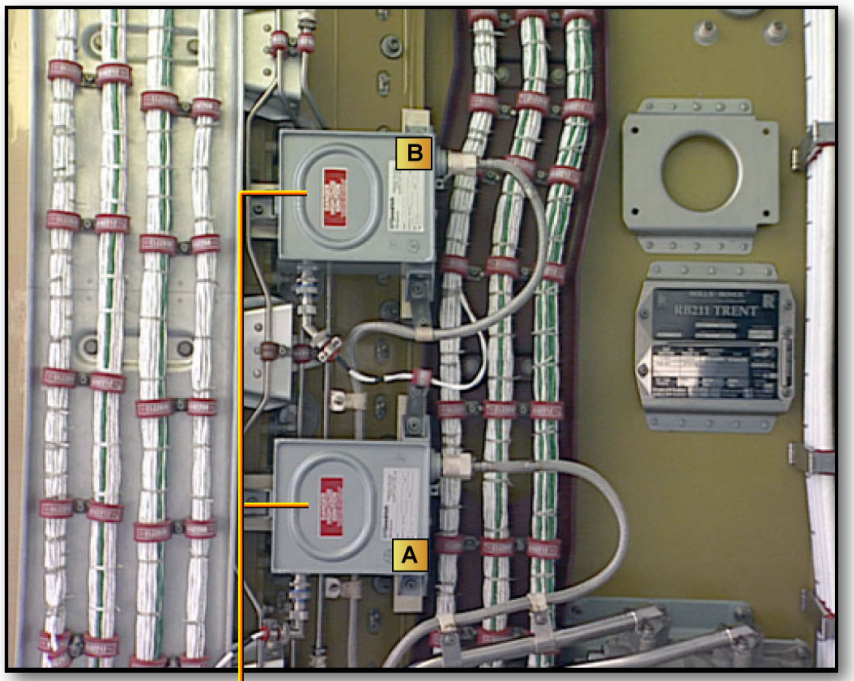
IGNITION UNITS

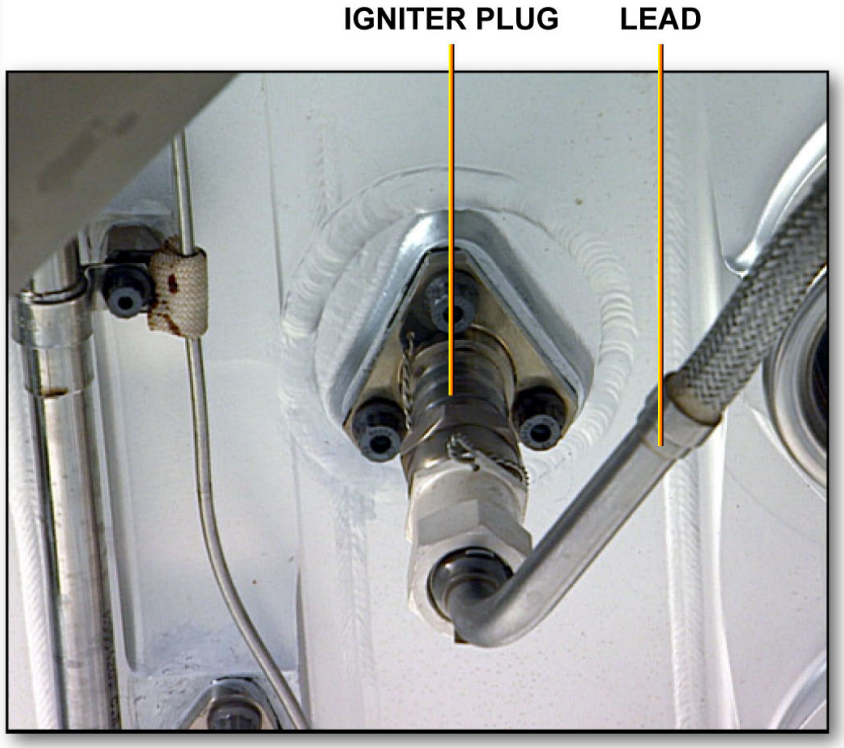
Two ignition units are installed on bracket assemblies on the lower LH side of the LP compressor case.
Each ignition unit changes electrical inputs into high voltage electrical outputs of between 2.7 and 3.0 Kvolts.
The ignition systems are of high-voltage and high-energy type.
Energy is stored in the ignition unit and is released at a rate of 60 to 135 sparks per minute.

IGNITER PLUGS AND LEADS

The igniter plugs are installed adjacent to the number 10 and number 16 fuel spray nozzles. Each igniter plug is directly supplied electrically from its associated ignition unit through an ignition lead.

GCL13151 - G6RT1DU - FM70DC000000071





IGNITION SYSTEM DESCRIPTION - IGNITION UNITS & IGNITER PLUGS AND LEADS

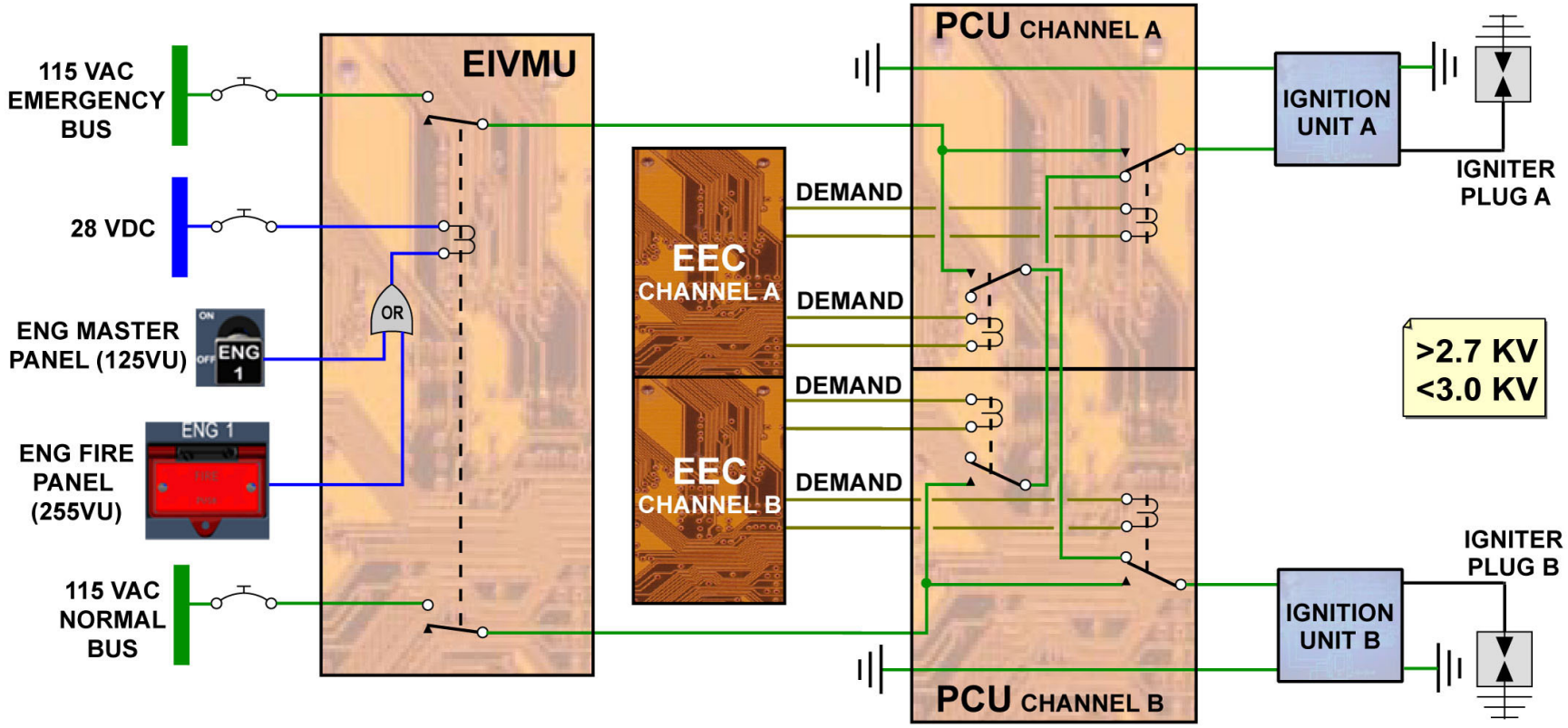
IGNITION AND STARTING D/O (3)

IGNITION SYSTEM DESCRIPTION (continued)

IGNITION SYSTEM POWER SUPPLY

Two inputs of 115 Volts 400 Hz AC power are supplied by the aircraft electrical system to the PCU through the EIVMU. The PCU electrical supply remains operational even if the EIVMU fails or is not powered.
The AC emergency bus is connected to two relays in PCU channel A and the AC normal bus is connected to two relays in PCU channel B.
The four relays of the PCU are controlled by the EEC to supply the ignition system A or system B, or both, with either emergency or normal aircraft 115 VAC power supply. The EEC thus cycles through the possible combinations of ignition systems and aircraft power supplies during successive engine starts.
The EEC automatic start logic selects a different ignition system from the previous start in order to identify any potential ignition system failure as soon as possible.
A functional test of the ignition system can be done through the EEC MCDU page, to check correct operation of any of the power supply and ignition unit combination.

GCL13151 - G6RT1DU - FM70DC000000071



IGNITION SYSTEM DESCRIPTION - IGNITION SYSTEM POWER SUPPLY

IGNITION AND STARTING D/O (3)

STARTING OPERATION

The Full Authority Digital Engine Control (FADEC) system gives two modes of engine start: automatic start and manual start. The EEC selects the start mode according to digital inputs from the EIVMU reflecting the cockpit settings.
The automatic starting sequence can be selected with valid EIVMU data or using an alternate start discrete if the EIVMU data is invalid. Manual start mode can only be selected with valid EIVMU data.

AUTOMATIC START ON GROUND

In automatic start mode, the igniters, fuel, and SCV are under full authority of the EEC.
The engine start initial configuration is:
- the ENG MASTER switch on the ENG MASTER panel in the OFF position,
- the selector on the ENG START panel in the NORM position,
- air pressure available and above 30 psi,
- electrical power available,
- engine fuel supply available.

To initiate the automatic start sequence, first the ENG START selector must be set to IGN/START position. The FADECs are then powered and the ENGINE system page comes up automatically on the ECAM SD. Start valve position and engine bleed pressure are shown on this page in place of nacelle temperature indication.
When an ENG MASTER switch is set to ON, the corresponding fuel LP valve opens and the associated EEC controls the SCV to the open position by energizing its solenoid. Air pressure is delivered to the pneumatic starter, which starts to rotate the N3 rotor. The FADEC continuously monitors N3 and Exhaust Gas Temperature (EGT) during the starting sequence.
When N3 reaches 25%, and EGT is below 150 degrees Celsius, the EEC commands the fuel supply by opening the fuel metering valve and the Pressure Raising and Shut Off Valve (PRSOV), and selects one ignition system on (A or B). The active ignition system is indicated on ECAM. The fuel flow starts to increase.
When N3 reaches 50%, the EEC closes the SCV and de-energizes the active igniter. The ECAM indication of the active igniter disappears.
The EEC continues to monitor the starting sequence until minimum idle is reached.
At the end of the sequence, the ENG START selector must be set back to NORM.

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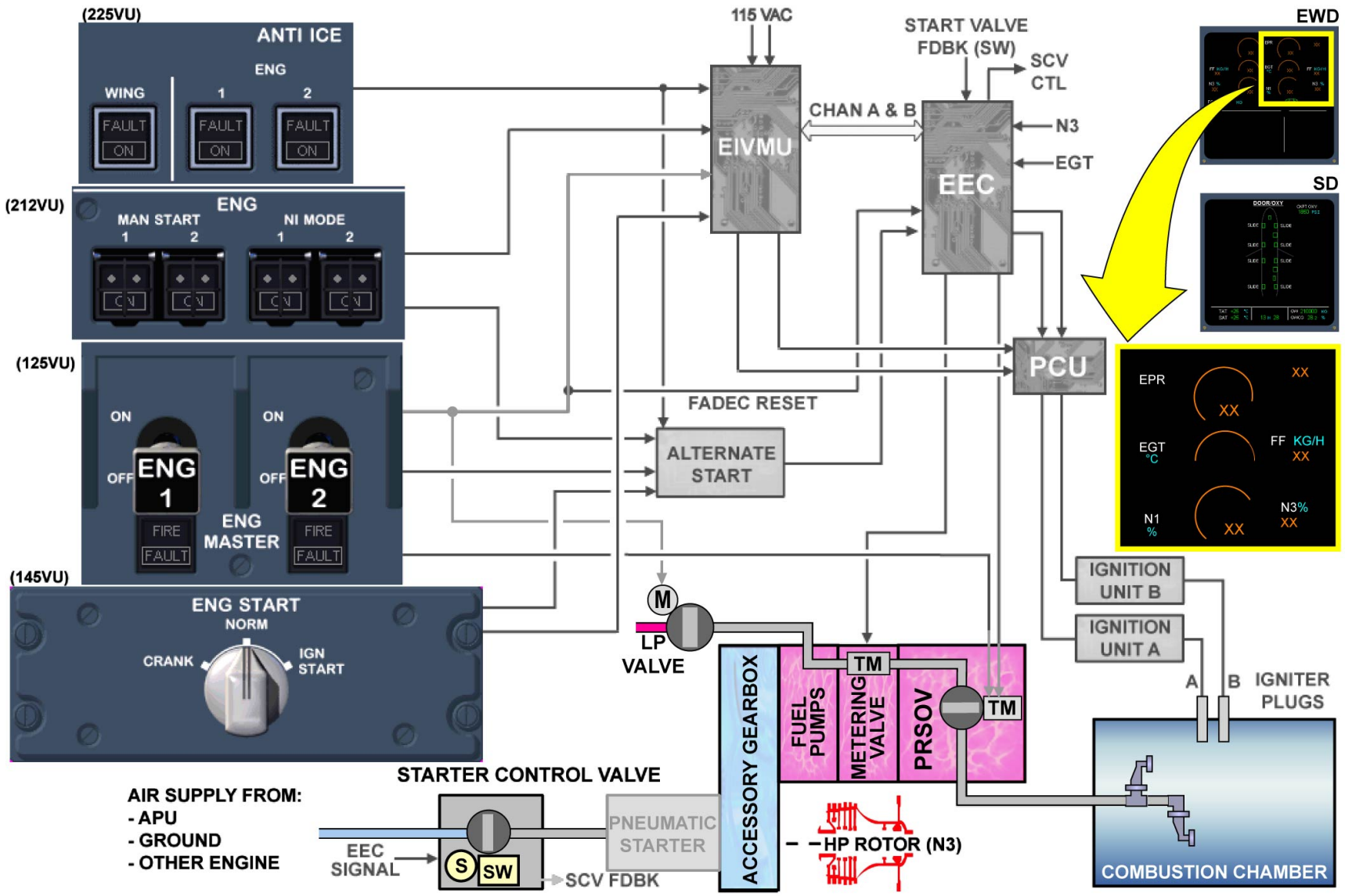
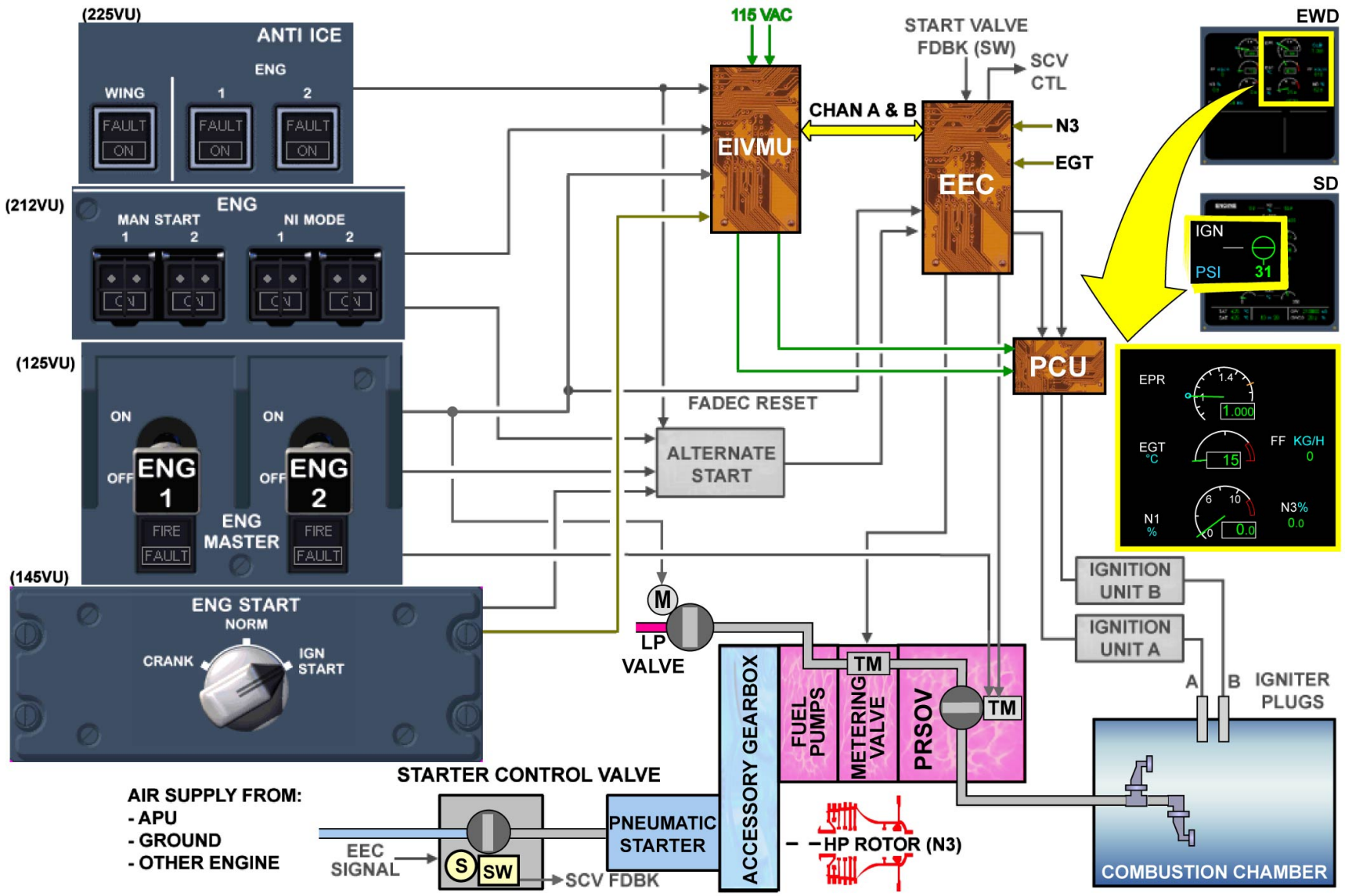
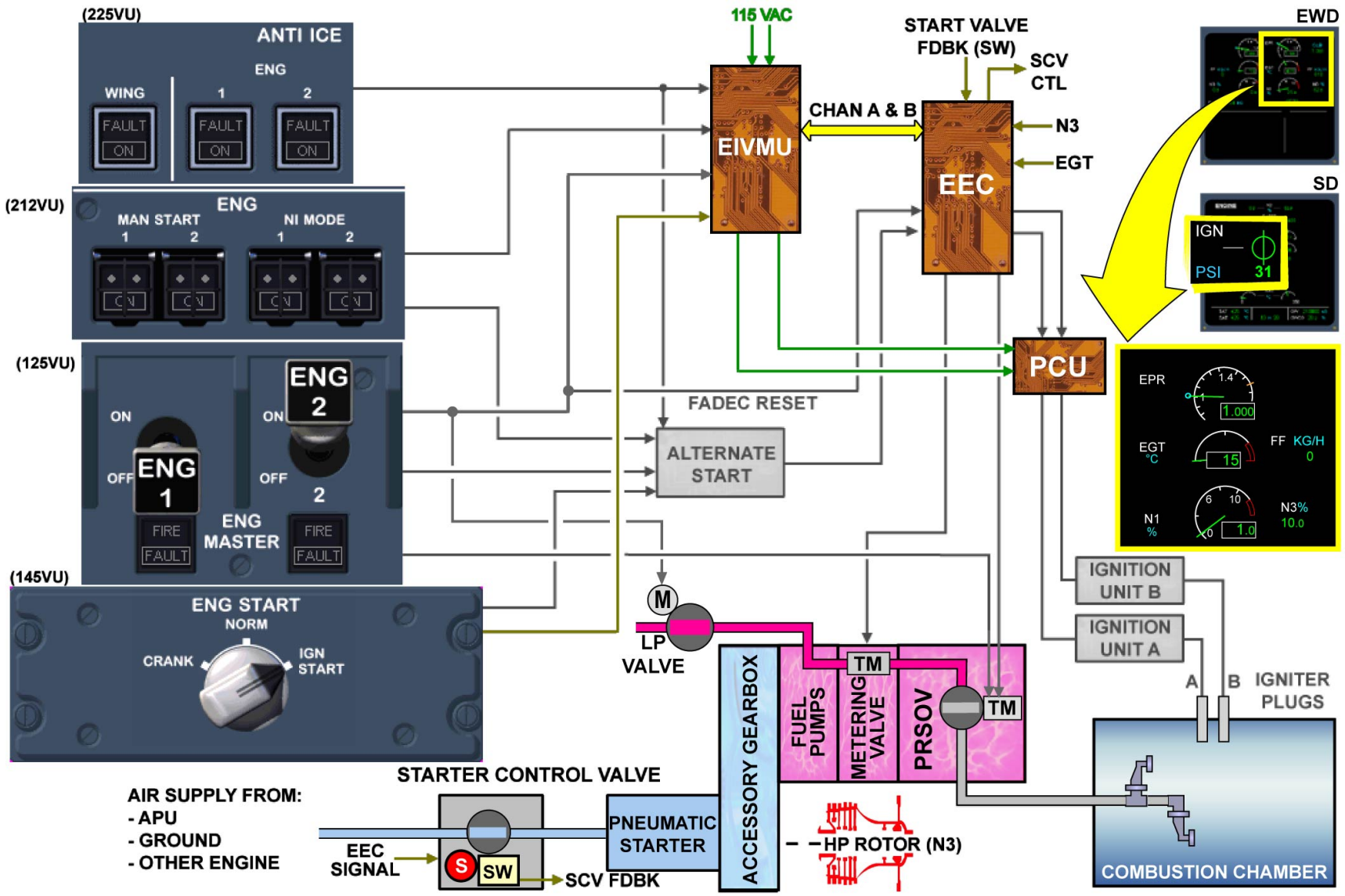


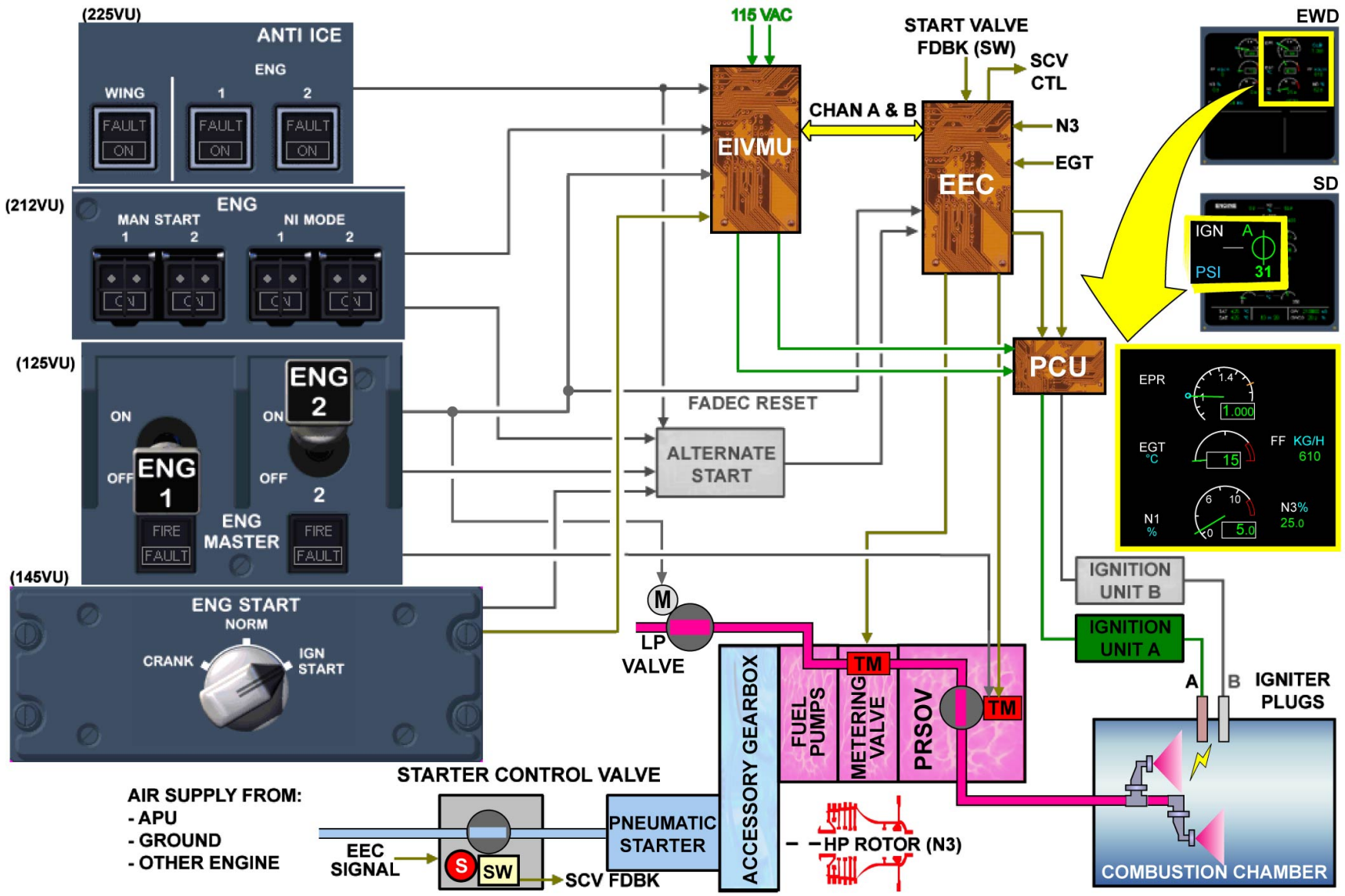
STARTING OPERATION - AUTOMATIC START ON GROUND



STARTING OPERATION - AUTOMATIC START ON GROUND



STARTING OPERATION - AUTOMATIC START ON GROUND



STARTING OPERATION - AUTOMATIC START ON GROUND

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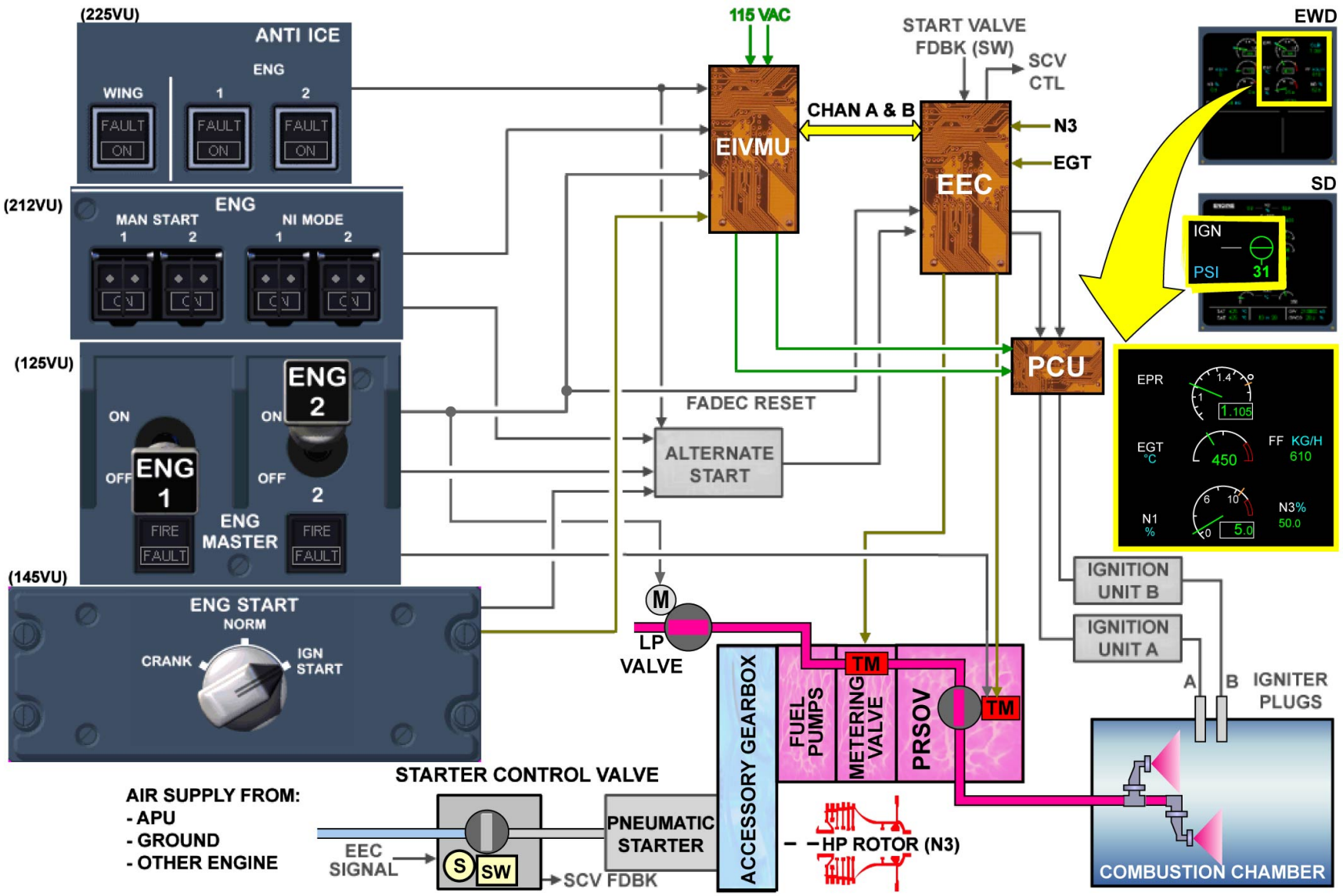
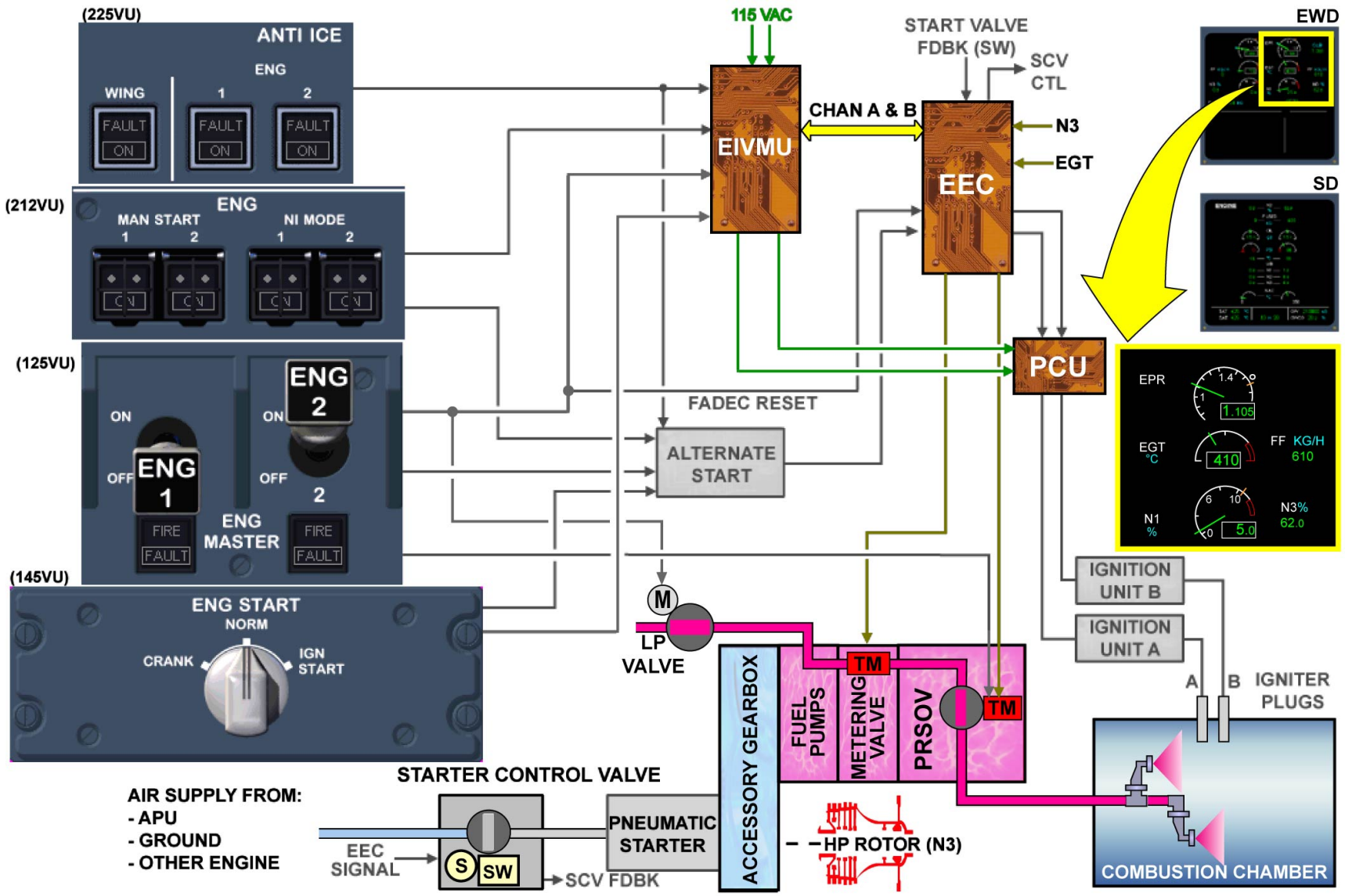


STARTING OPERATION - AUTOMATIC START ON GROUND



STARTING OPERATION - AUTOMATIC START ON GROUND

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GCL13151 - G6RT1DU - FM70DC000000071

IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

MANUAL START ON GROUND

A manual start procedure is recommended at high altitude airports, during hot weather conditions, or any time the pneumatic pressure delivered to SCV is low.

In manual start mode, starting control is under limited authority of the EEC. The SCV, fuel supply and igniters are controlled by the crew using a conventional procedure. The initial conditions to start the engine in manual mode are identical to those of the automatic start.

To initiate a manual start sequence, the ENG START selector must be set to IGN/START position. Both EECs are then powered and the ENGINE system page comes up automatically on the ECAM SD. The EEC ensures only a passive monitoring of the manual start sequence.

The associated ENGine MANual START P/B is set to ON position and the EEC opens the SCV, allowing the pneumatic starter to rotate the N3 rotor.

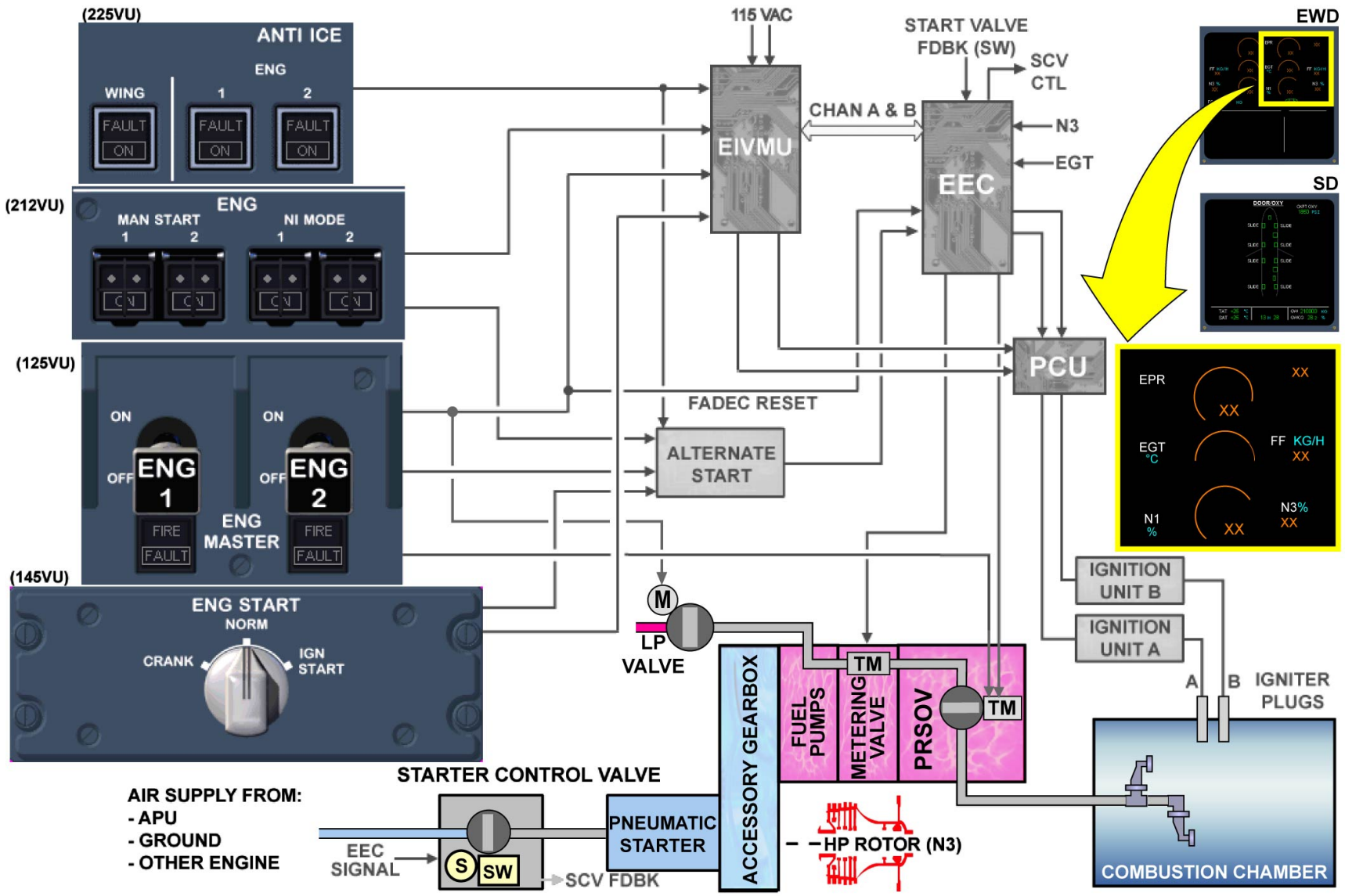
When N3 reaches its maximum motoring speed and at least 25%, the associated ENG MASTER switch has to be selected ON.

Then, the EEC commands the fuel supply by opening the metering valve and the PRSOV and selects both ignition systems on. The fuel flow starts to increase. The EEC monitors the N3.

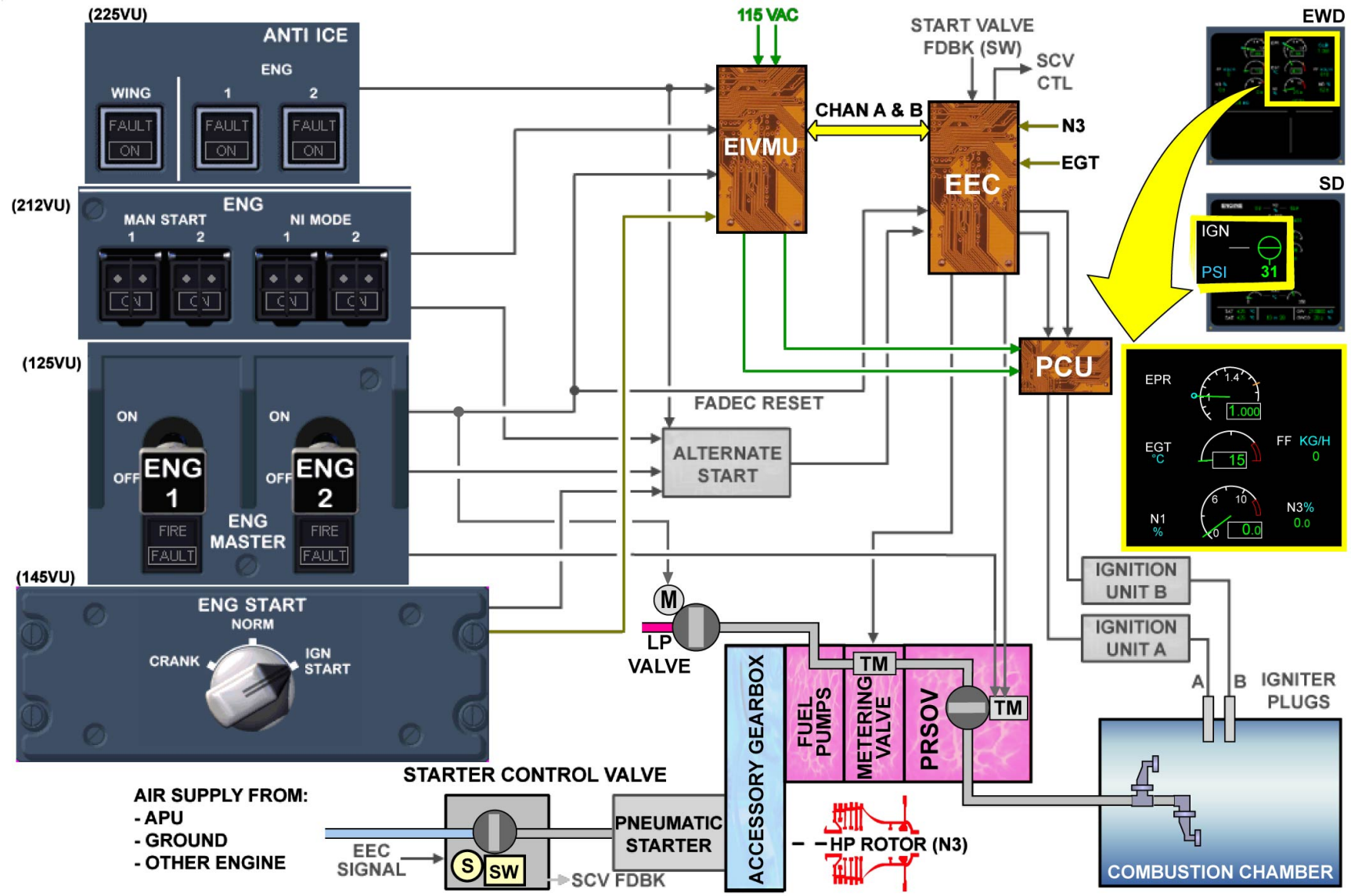
When N3 reaches 50%, the EEC closes the SCV and de-energizes both ignition systems.

Once the start sequence is completed, the ENG START selector is set back to NORM position and the ENG MAN START P/B is set back to OFF.

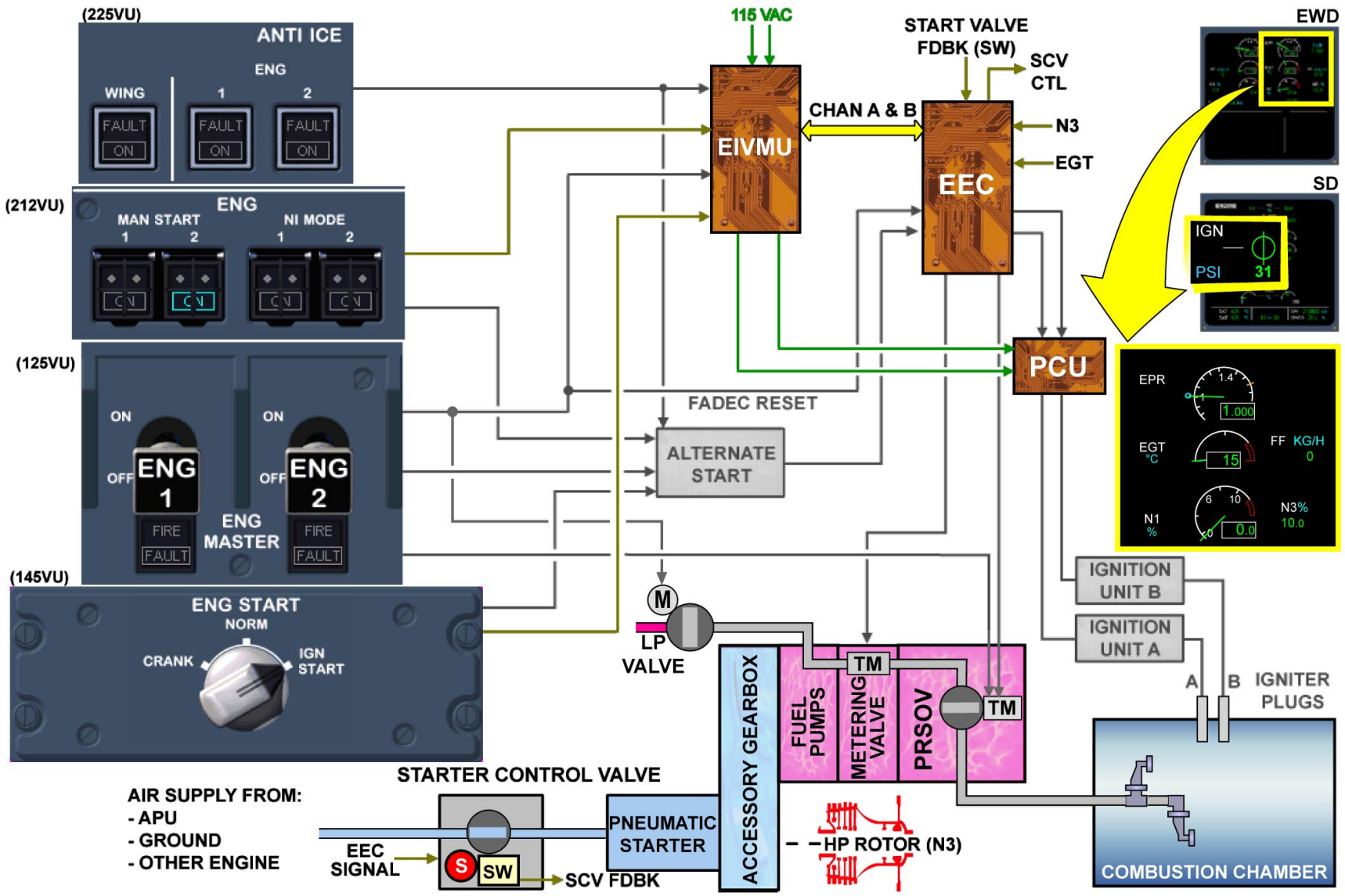
GCL13151 - G6RT1DU - FM70DC000000071



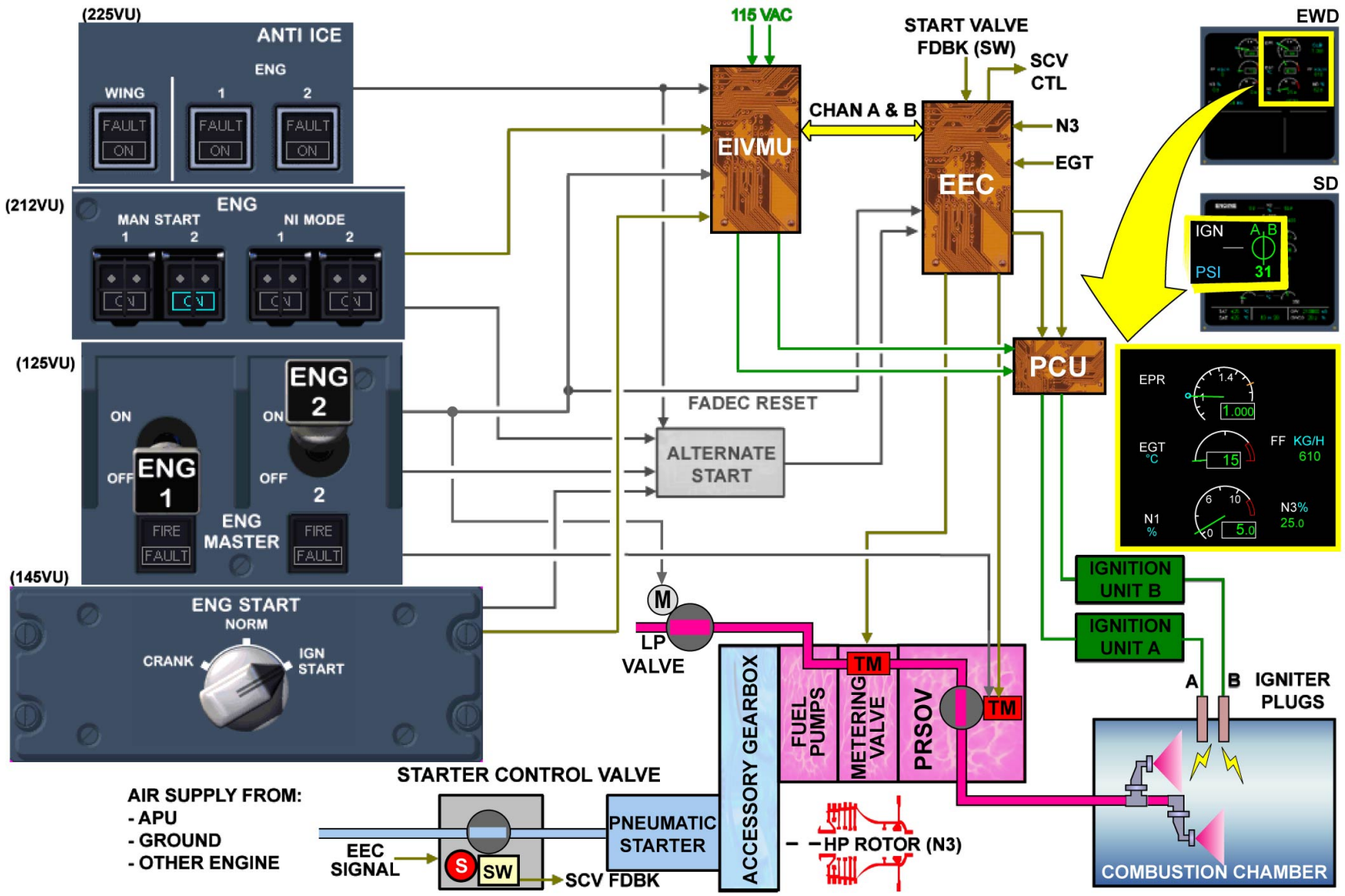
STARTING OPERATION - MANUAL START ON GROUND



STARTING OPERATION - MANUAL START ON GROUND

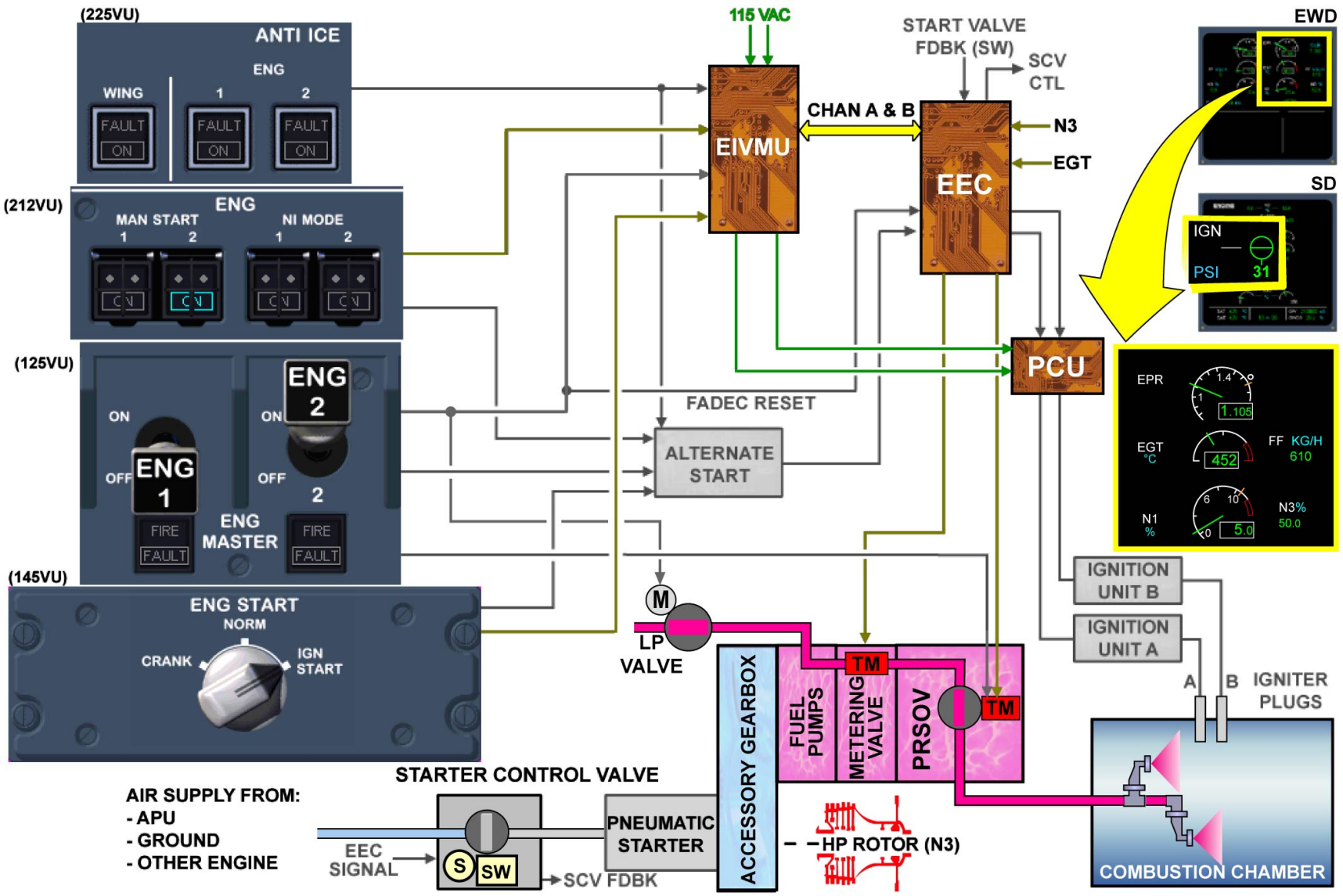


STARTING OPERATION - MANUAL START ON GROUND



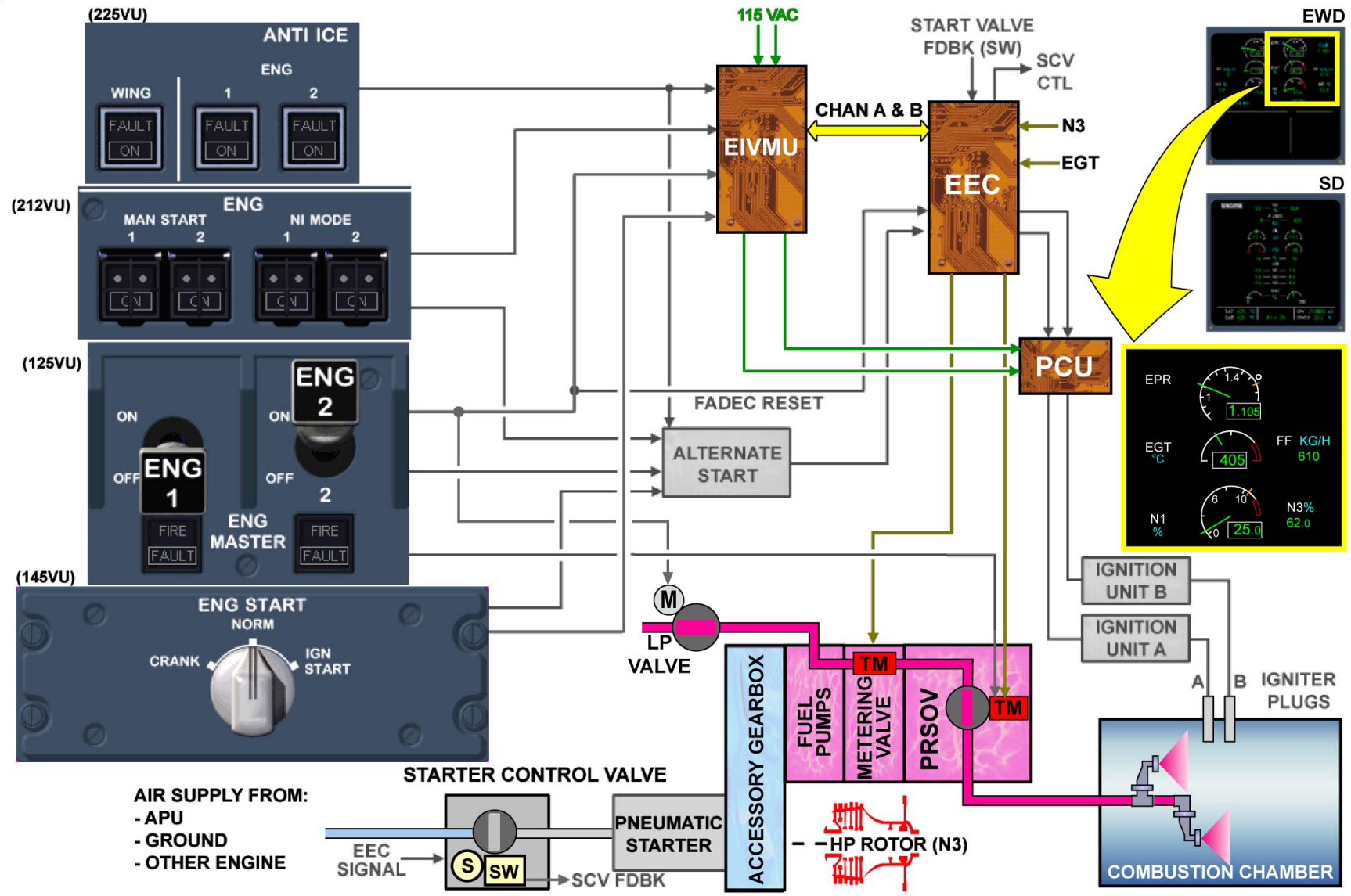
STARTING OPERATION - MANUAL START ON GROUND

GCL13151 - G6RT1DU - FM70DC000000071



STARTING OPERATION - MANUAL START ON GROUND

GCL13151 - G6RT1DU - FM70DC000000071



STARTING OPERATION - MANUAL START ON GROUND

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GCL13151 - G6RT1DU - FM70DC000000071

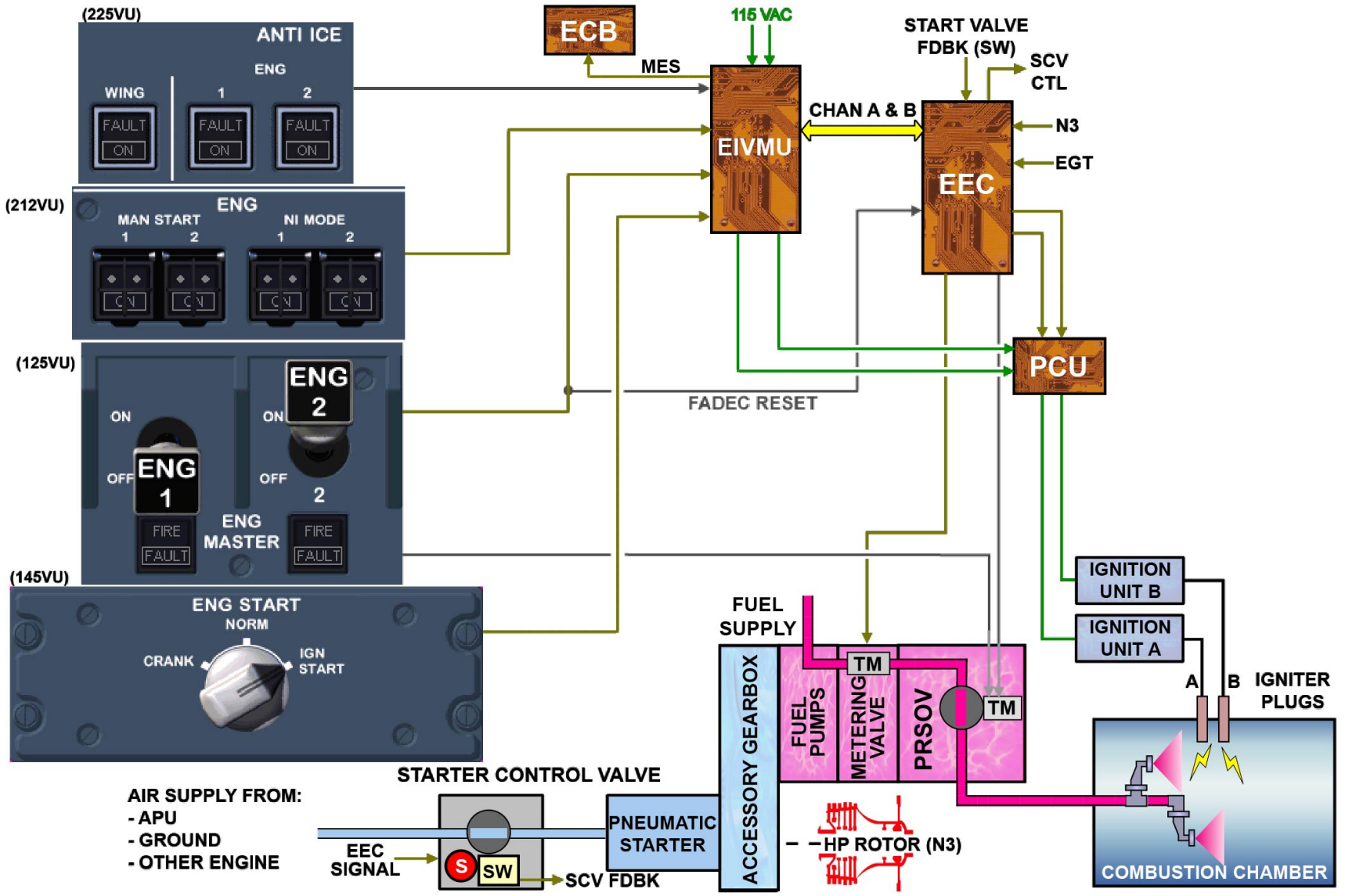
IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

APU BOOST

During an automatic or manual start using APU bleed, when the ENG START selector is set to IGN/START position, the APU Electronic Control Box (ECB) receives a Main Engine Start (MES) input signal via the EIVMU to boost the APU bleed airflow.
When N3 reaches 50%, the ECB sets the bleed airflow back to normal.

GCL13151 - G6RT1DU - FM70DC000000071



STARTING OPERATION - APU BOOST

IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

ALTERNATE START DISCRETE LOGIC

In normal operation, engine starting/shutdown/ignition control is initiated by the EEC based on the position of switches on the engine control panels. The discrete signals from these switches are sent to the EIVMU, converted into digital data and transmitted to the EEC. So that an EIVMU failure should not prevent the aircraft dispatch, an alternate start discrete logic has been designed to allow the main starting functions to be maintained.

When EIVMU data are not available, the alternate start discrete logic lets the EEC peform an automatic start, dry motoring or selection of continuous ignition. The alternate start discrete logic integrates the position of the following controls:

- the ENG START rotary selector,
- the ENG MASTER switch,
- the ENG MANual START P/B,
- the ENG ANTI ICE P/B and,
- the engine running discrete (N3>50%).

When IGN START is selected and the ENG MASTER switch is set to ON the EEC initiates an automatic start.

When CRANK is selected and the MAN START P/B is pressed in the EEC initiates the dry motoring procedure.

When IGN START is selected and the engine is running, the EEC selects continuous ignition.

When ENG ANTI ICE is selected while the engine is running, the EEC selects continuous ignition.

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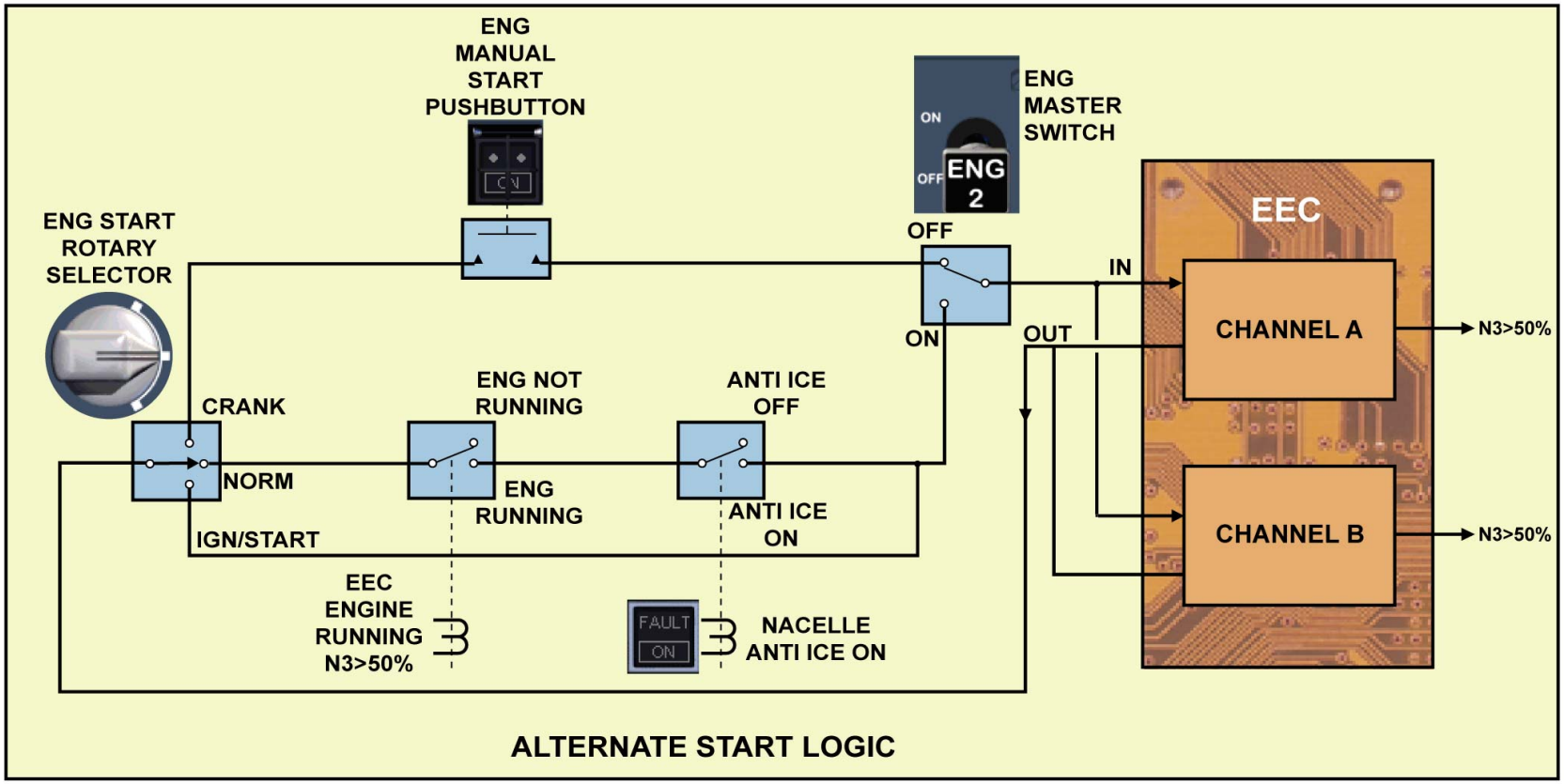
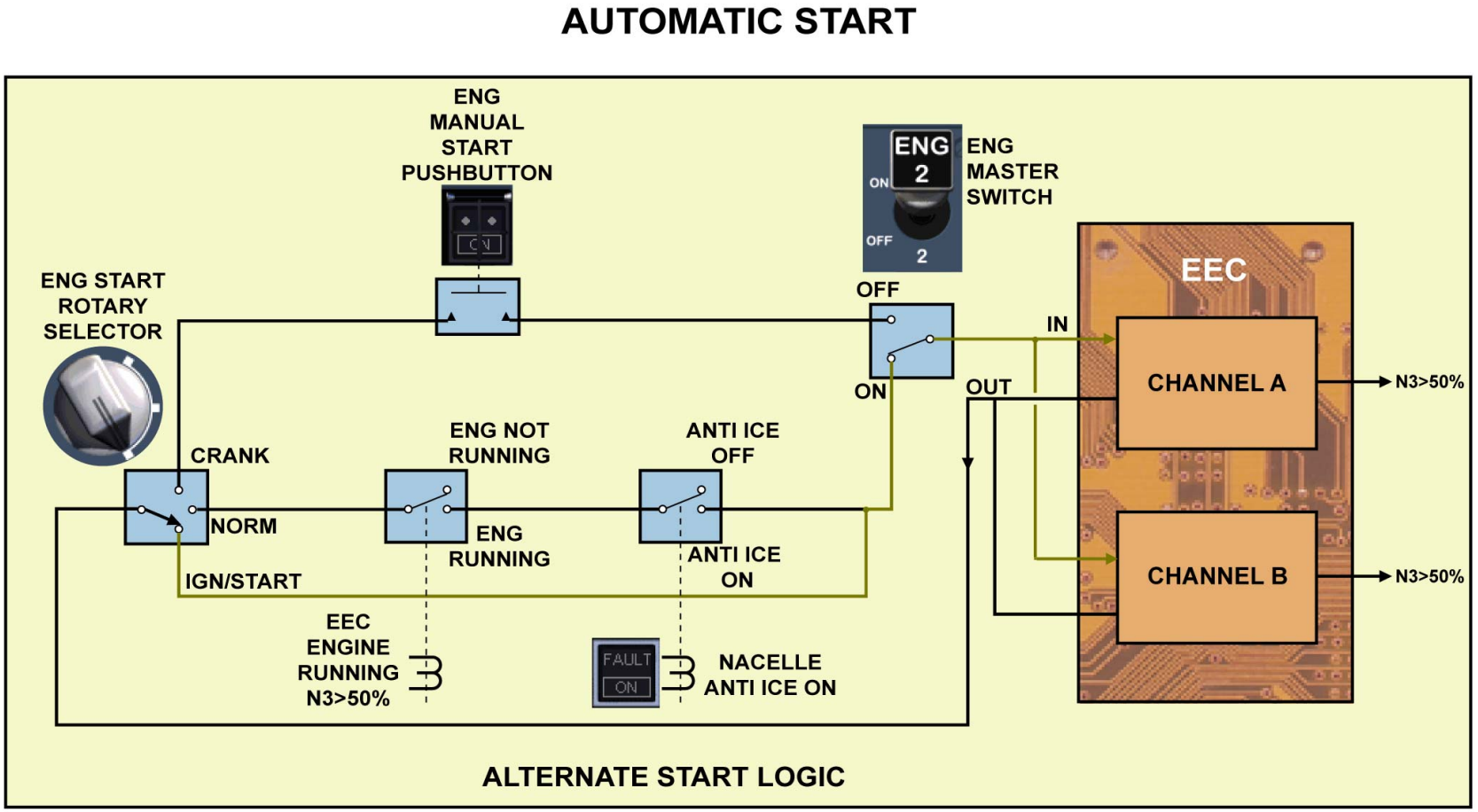
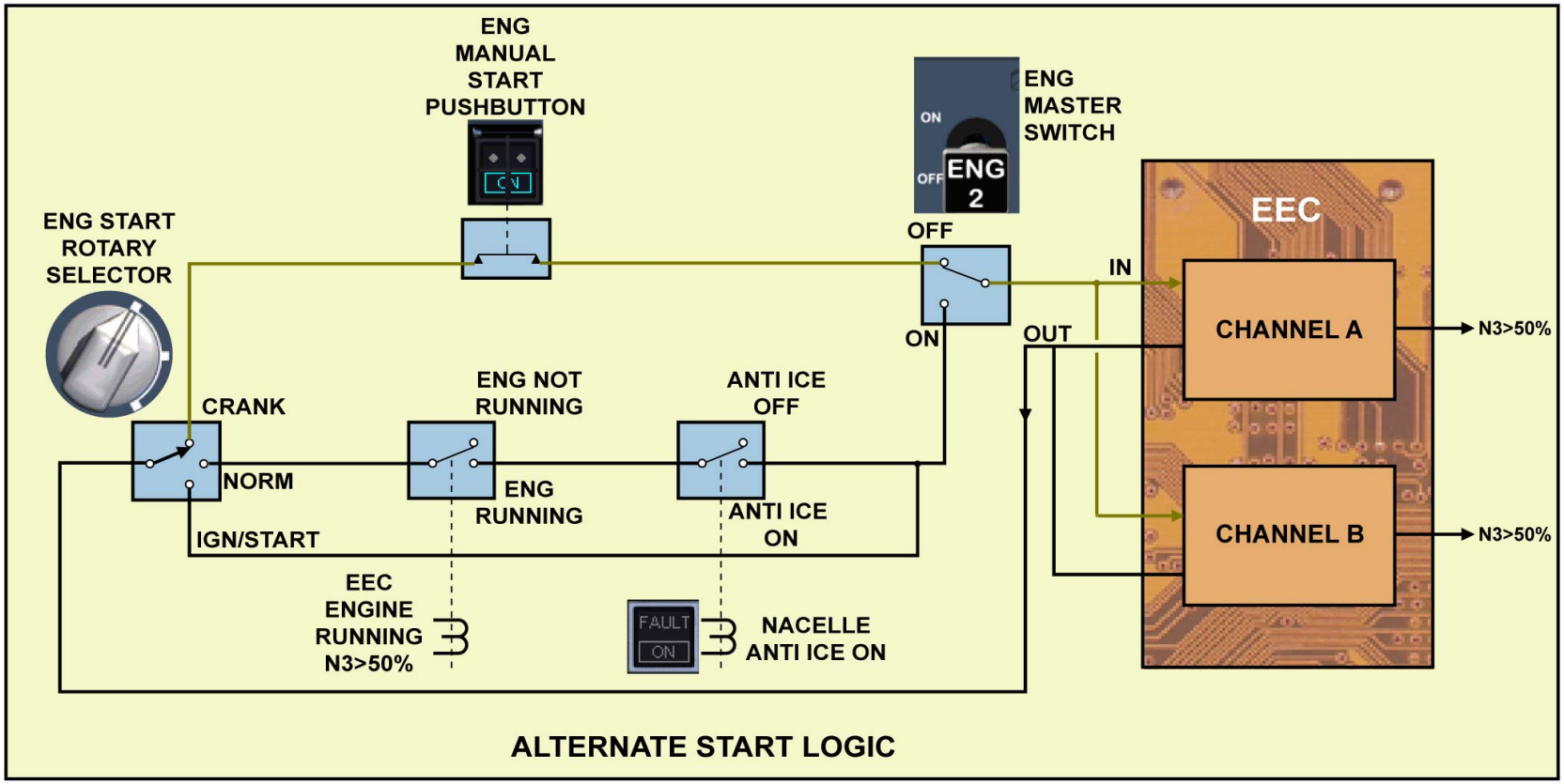


STARTING OPERATION - ALTERNATE START DISCRETE LOGIC



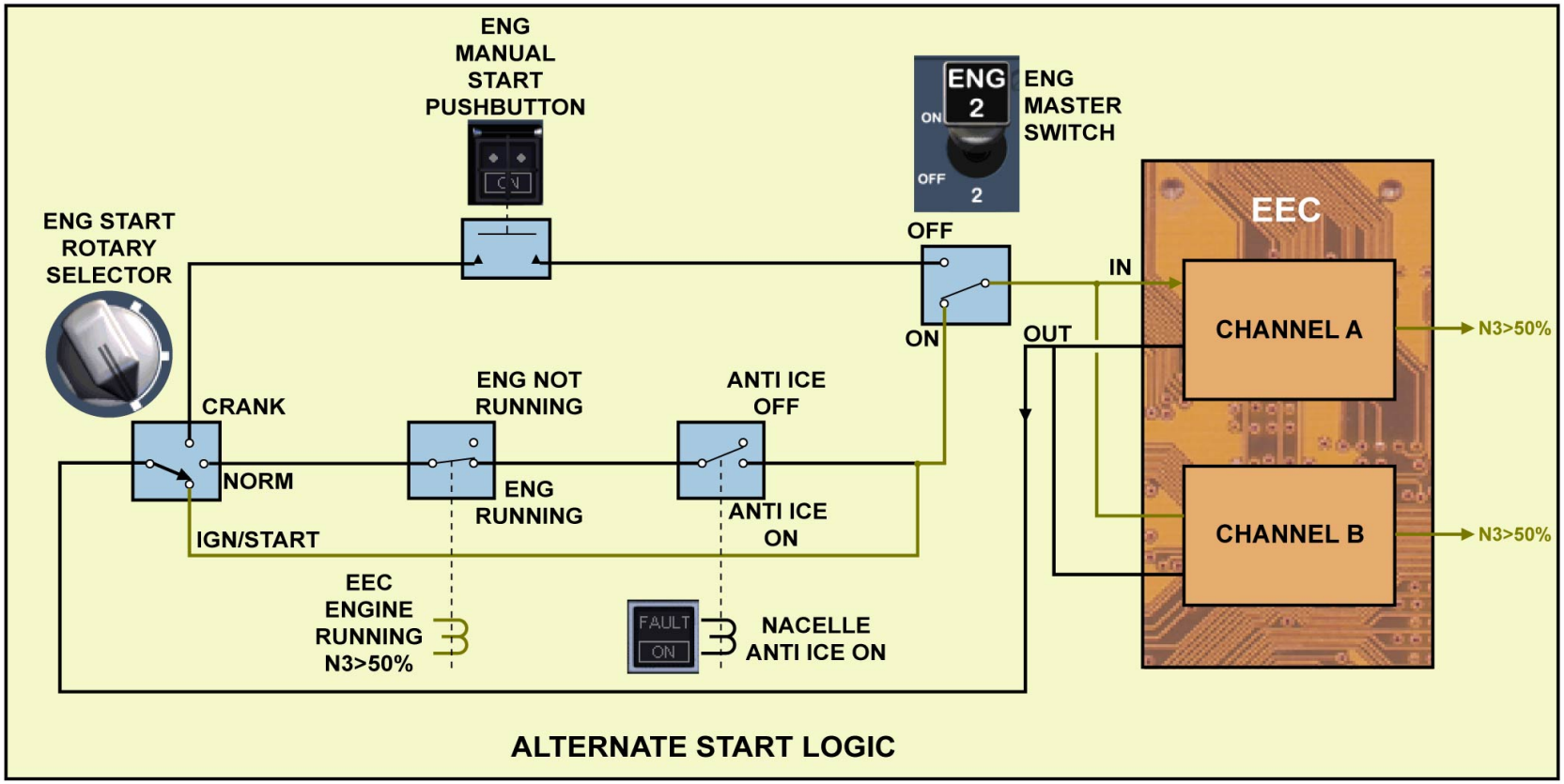
STARTING OPERATION - ALTERNATE START DISCRETE LOGIC

DRY MOTORING



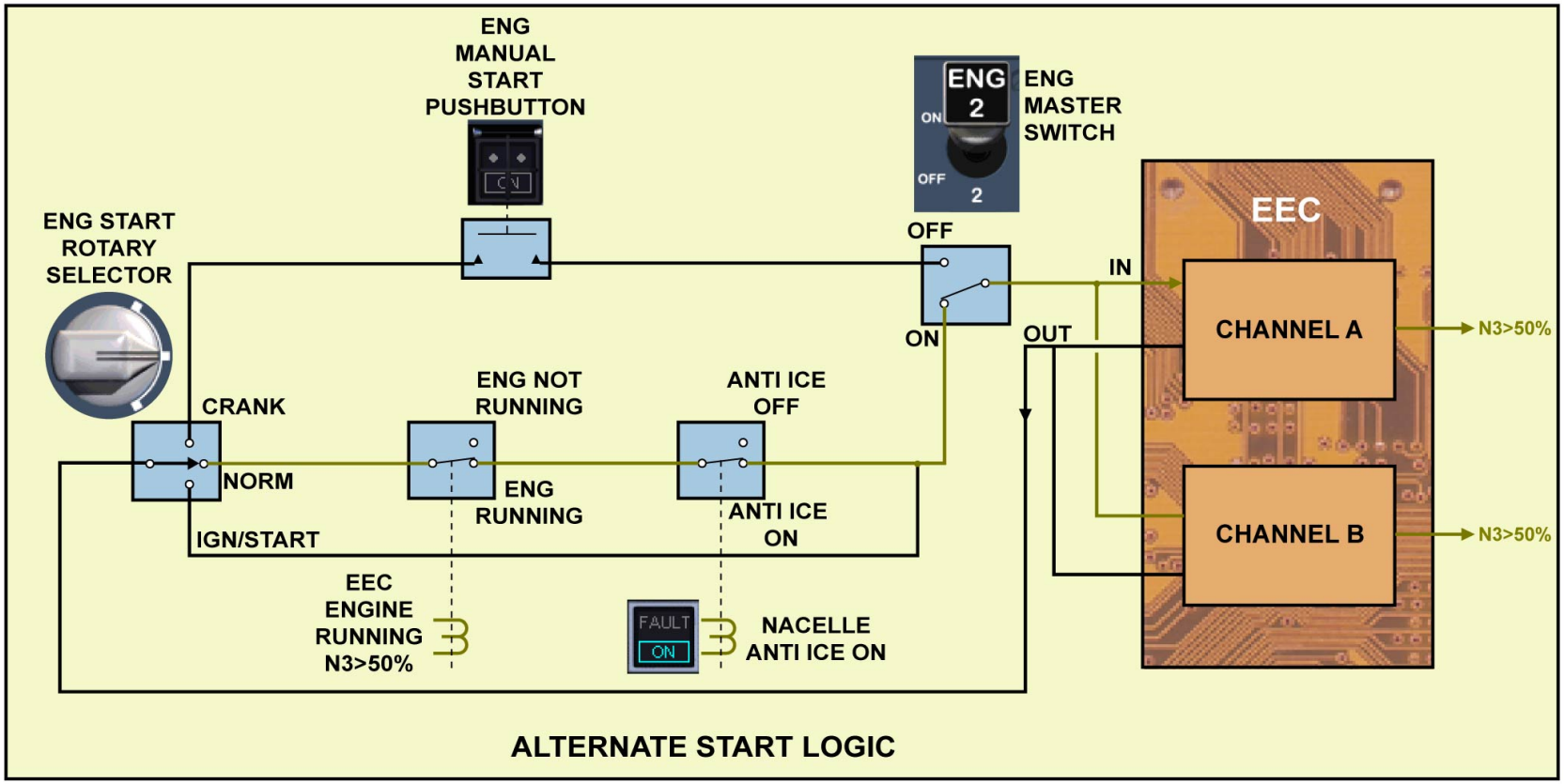
STARTING OPERATION - ALTERNATE START DISCRETE LOGIC

CONTINUOUS IGNITION



STARTING OPERATION - ALTERNATE START DISCRETE LOGIC

CONTINUOUS IGNITION WITH ANTI-ICE



STARTING OPERATION - ALTERNATE START DISCRETE LOGIC

IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

AUTO START MANUAL ABORT

The automatic and manual start sequence can be interrupted by placing the ENG MASTER switch back to the OFF position. This causes:
- closure of the PRSOV directly,
- closure of the SCV,
- de-energization of the igniters.

Turning the ENG START selector switch to NORM or CRANK while the automatic start sequence is already initiated has no effect.

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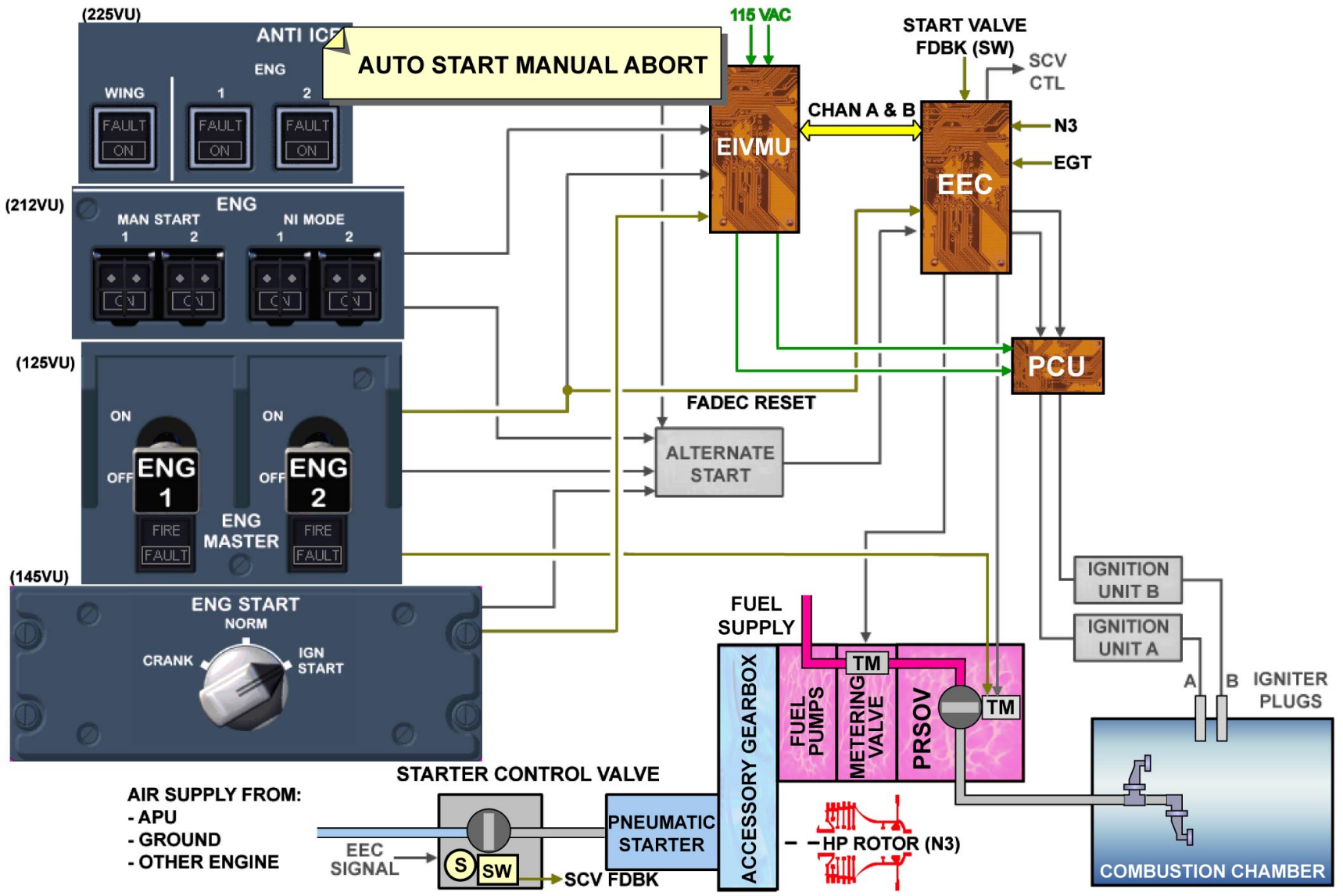

STARTING OPERATION - AUTO START MANUAL ABORT

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IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

MANUAL START ABORT BEFORE MASTER LEVER ON

In manual start mode, if the ENGine MANual START P/B is released out before the ENG MASTER switch is set to ON, the SCV will close and abort the manual starting sequence.

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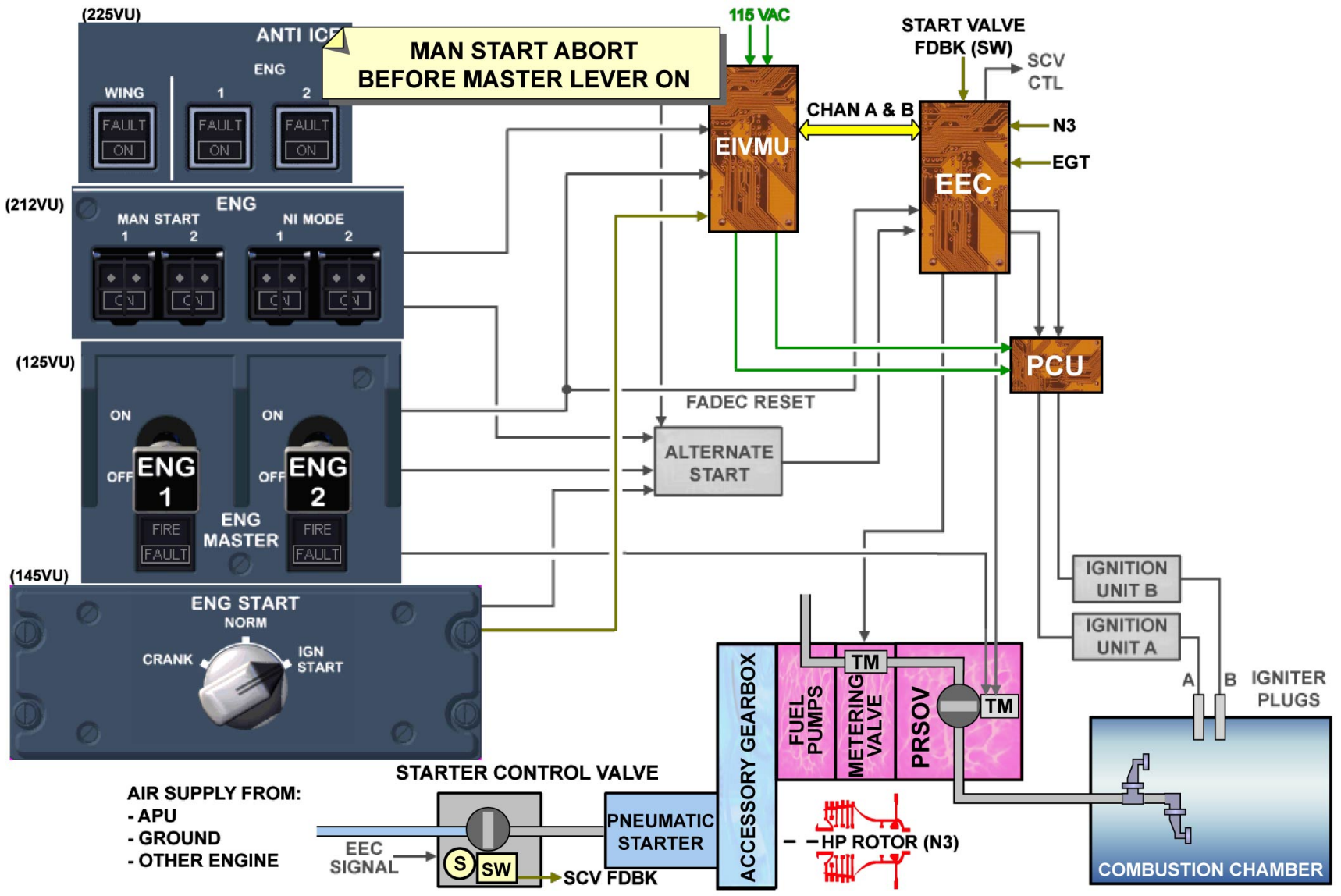

STARTING OPERATION - MANUAL START ABORT BEFORE MASTER LEVER ON

GCL13151 - G6RT1DU - FM70DC000000071

IGNITION AND STARTING D/O (3)

STARTING OPERATION (continued)

AUTO START ABORT DUE TO EGT OVERLIMIT

On ground only, the EEC can abort an automatic start sequence for the following conditions:
- hot start (EGT overlimit),
- hung start (no acceleration),
- no light up (no ignition),
- stall,
- locked N1 rotor.

In case of hot start, stall or no light up, the EEC cuts off the fuel supply and ignition, does an automatic dry cranking and initiates a second start attempt when the EGT is below 150 degrees Celsius. If the second start attempt is not successful, the starting sequence is aborted. A warning is displayed on ECAM and the FAULT light illuminates on the ENG MASTER panel.

Set the ENGine MASTER lever to ON position to open the starter valve and the LP valve.

When N3 reaches 25%, one ignition system is excited. At each start, the EEC selects alternatively one ignition system A or B. The second igniter can be turned on for a delayed or no light operation.

The EGT reaches the EGT overlimit.

The EEC starts a dry crank until the EGT reaches 150°C.

The EEC restarts the engine with the two igniters A and B.

When N3 reaches 50%, the SAV closes and the starter valve is closed.

The EEC considers that the start sequence is completed when the engine reaches the minimum idle core speed. Then the rotary selector is turned back to the NORM position.

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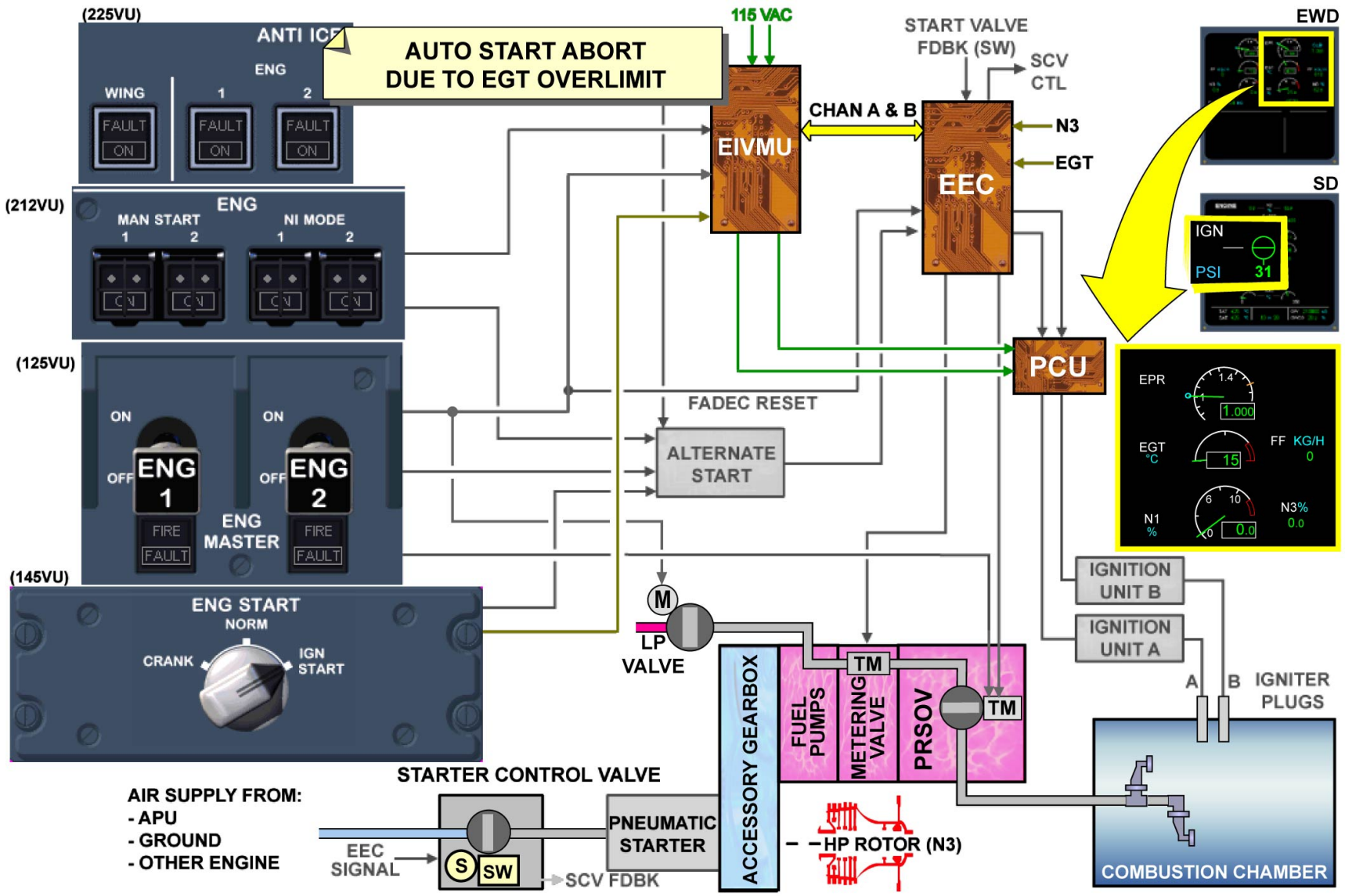
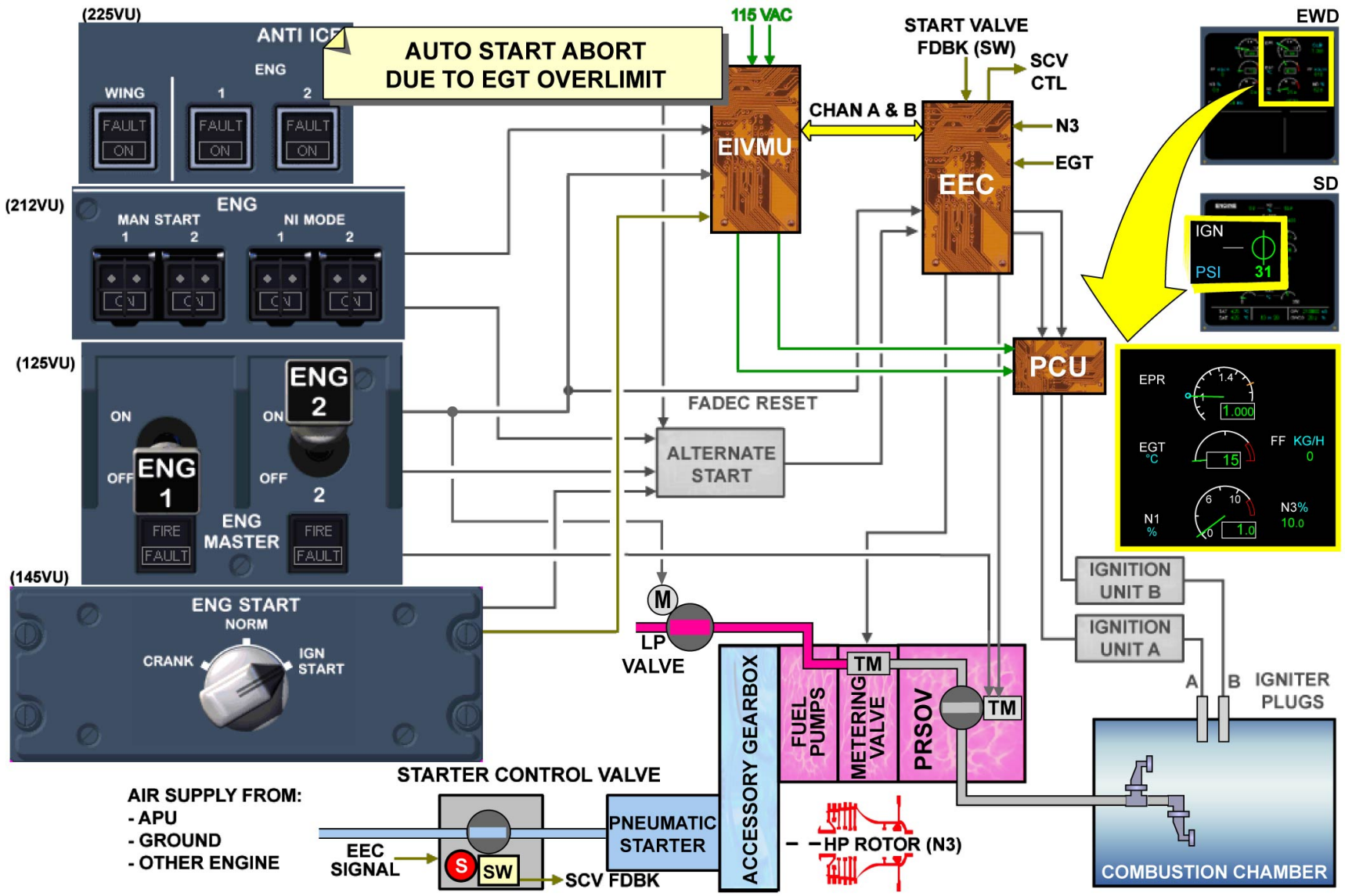


STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT



STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT

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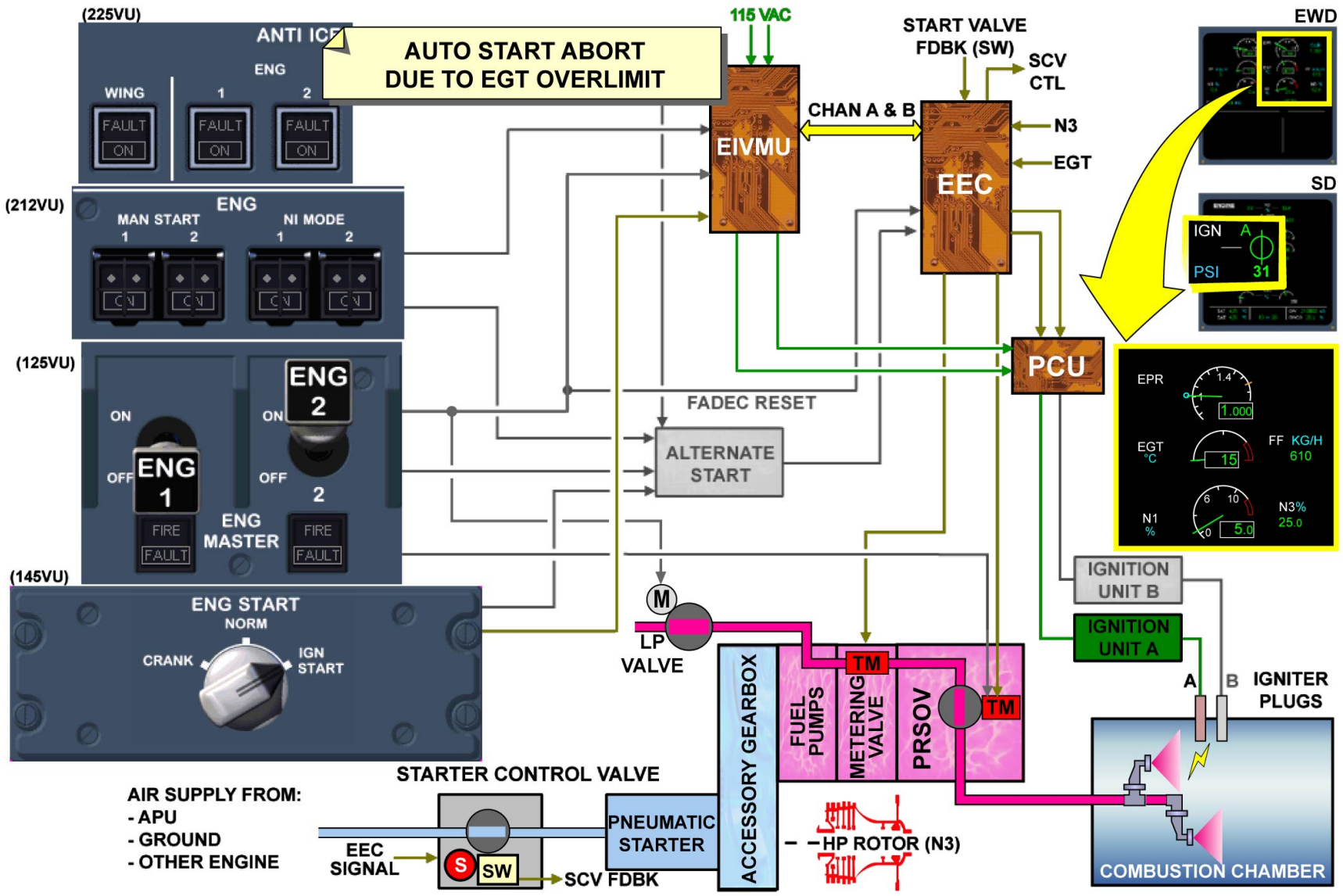

STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT

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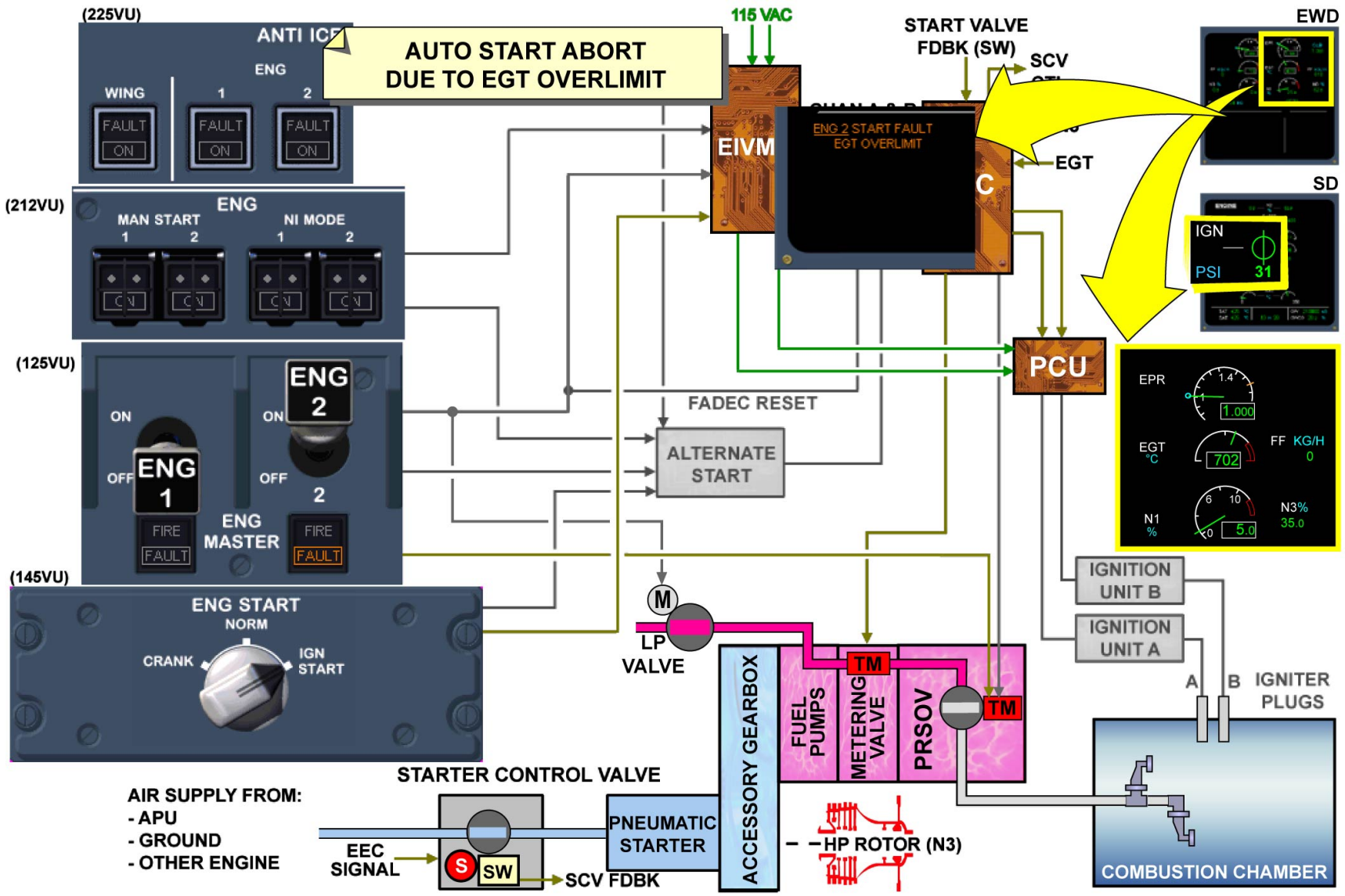
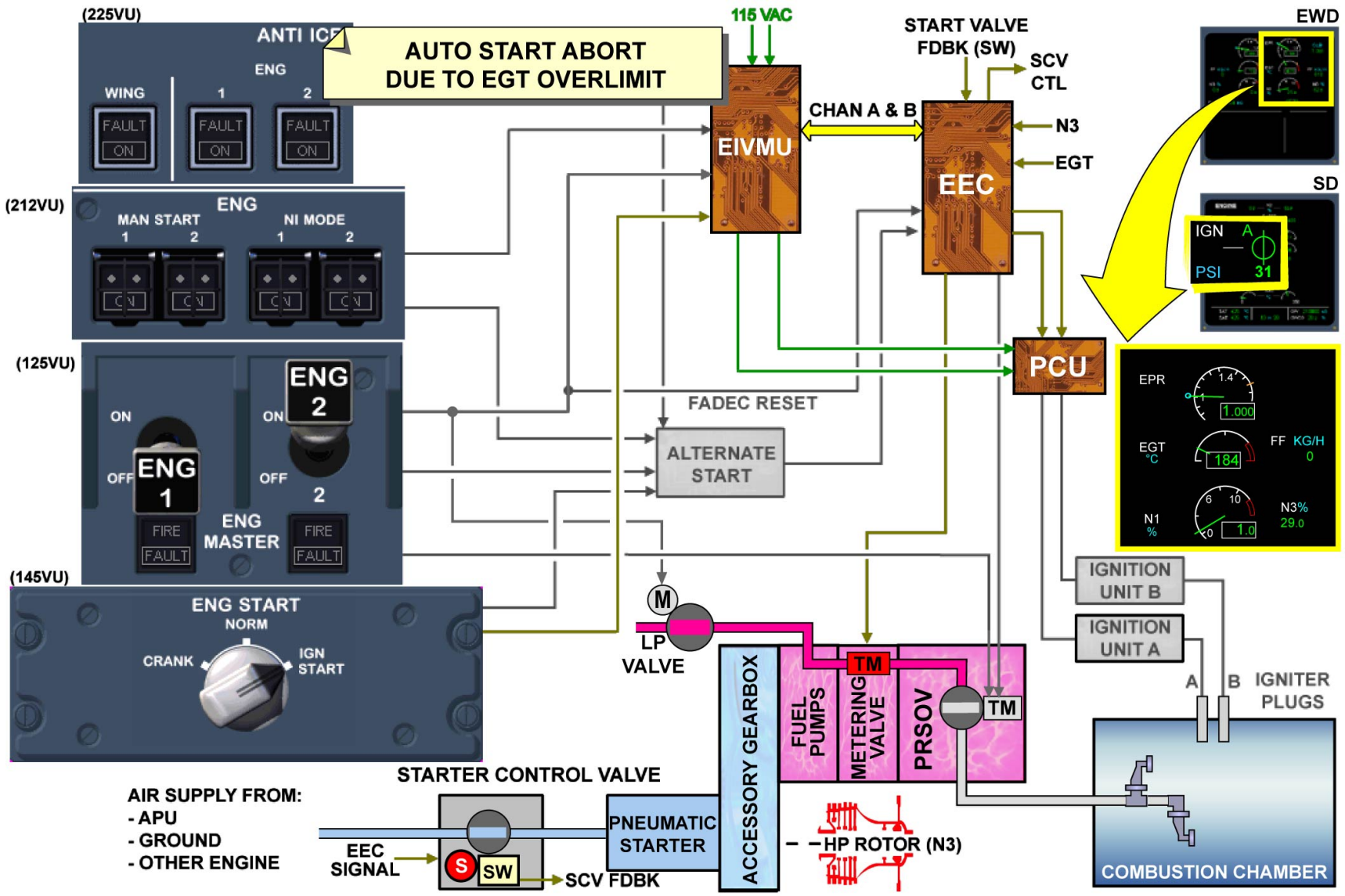


STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT



STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT

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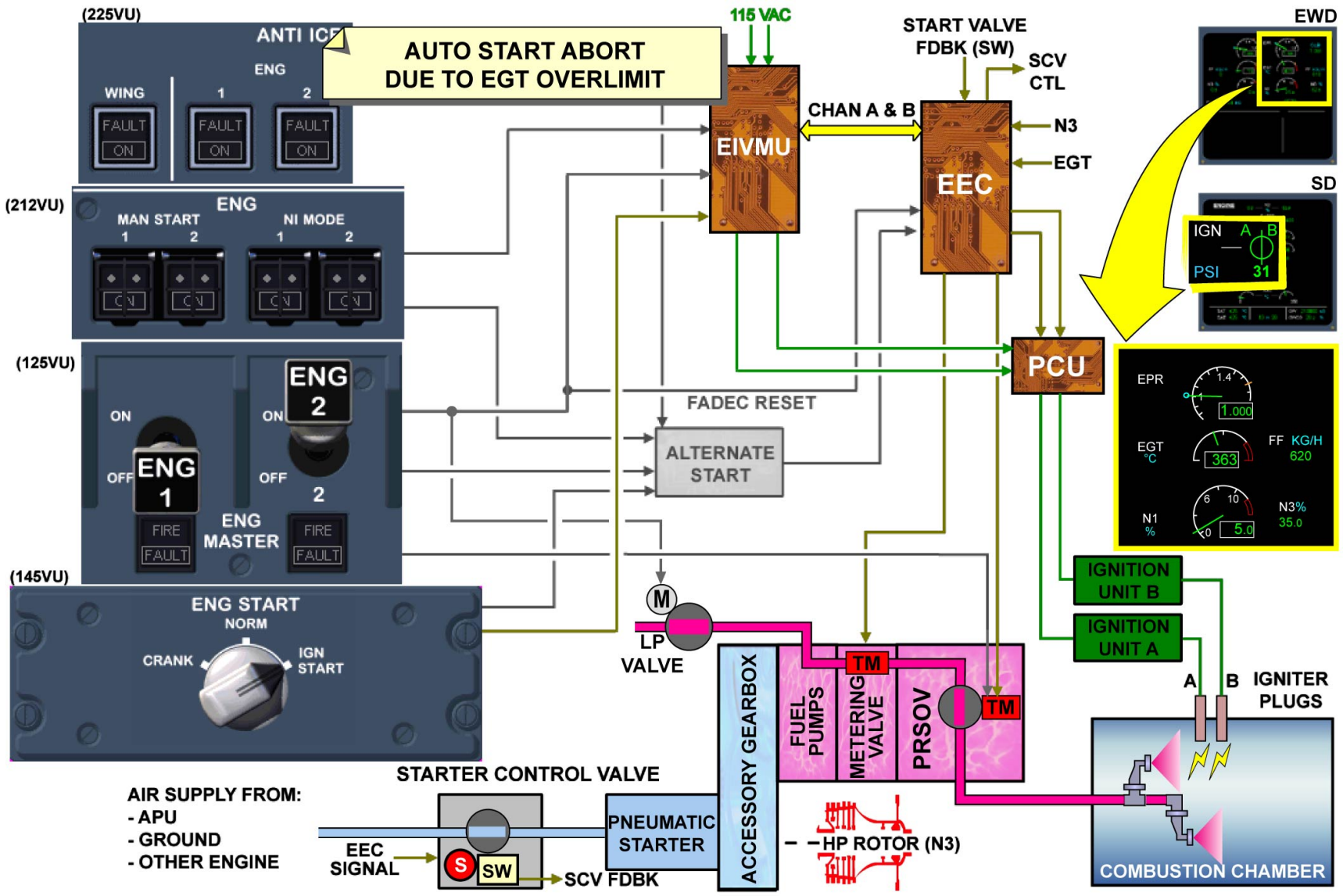
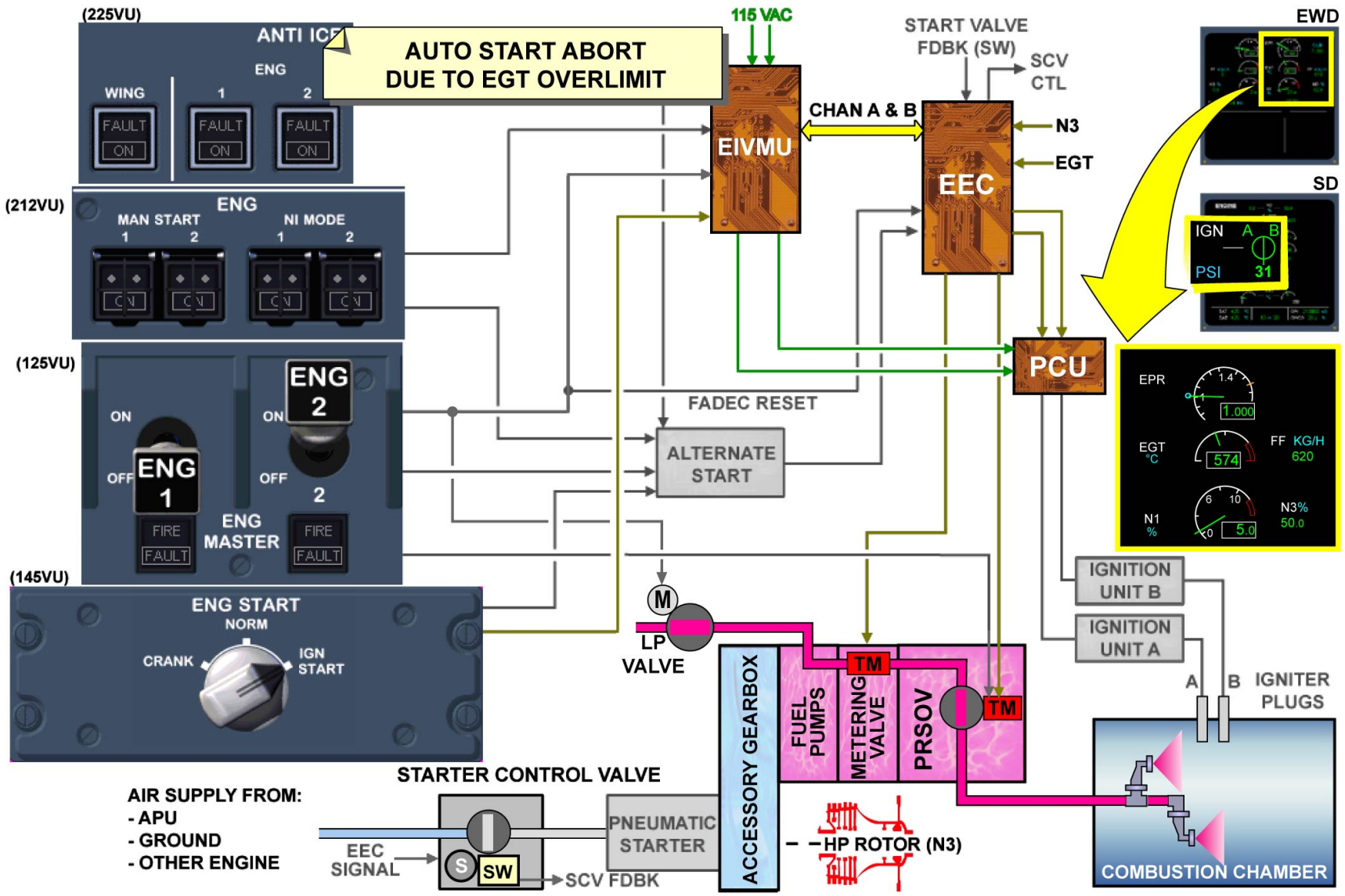


STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT



STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT

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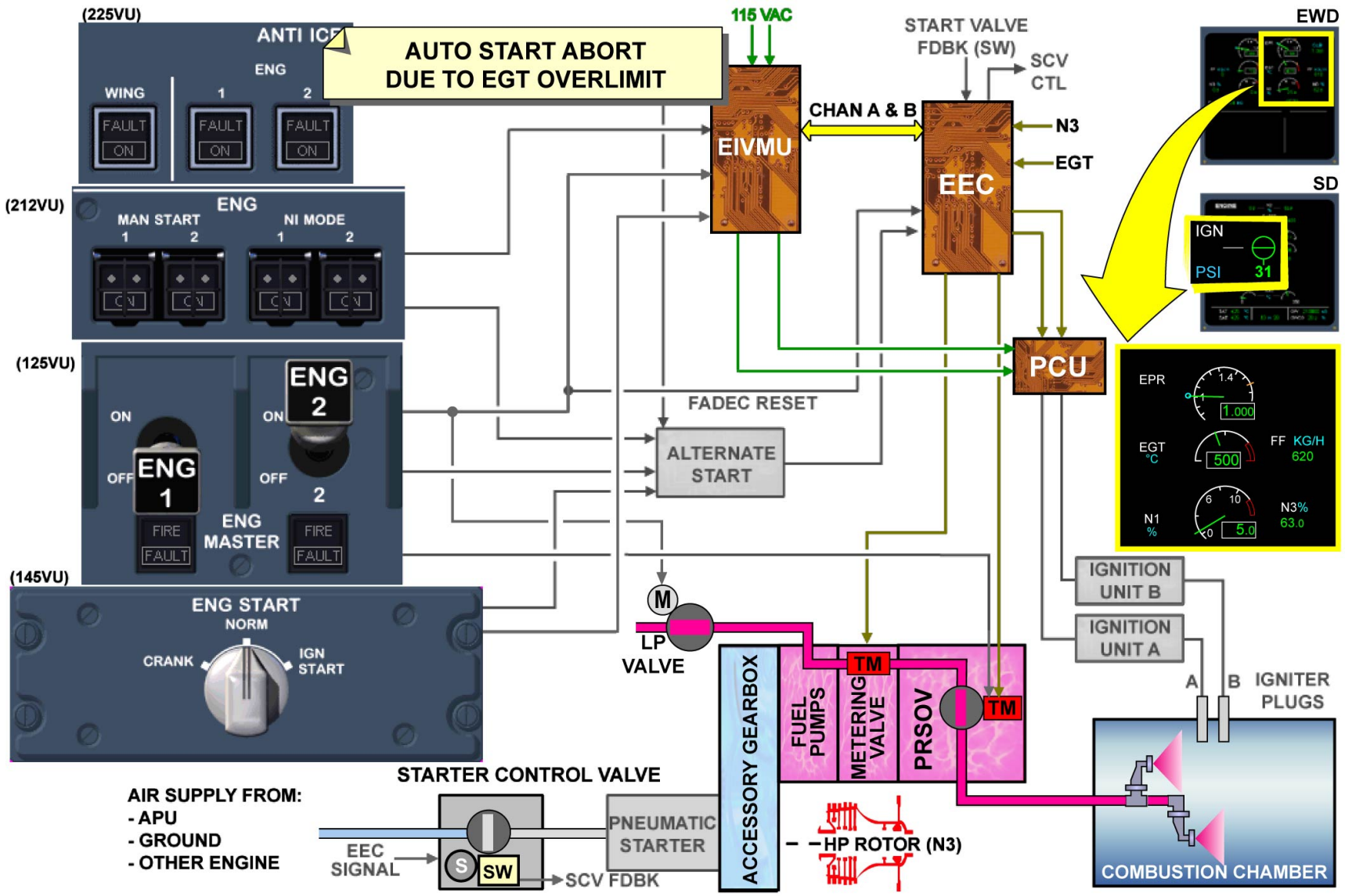

STARTING OPERATION - AUTO START ABORT DUE TO EGT OVERLIMIT

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IGNITION AND STARTING D/O (3)

CONTINUOUS IGNITION OPERATION

Besides the normal automatic or manual start modes, the EEC is able to control continuous ignition depending on cockpit selections, or on an abnormal engine condition detection. In each case, the purpose of the continuous ignition selection is to maintain or recover normal engine operation. Both igniter plugs are energized in the continuous ignition mode and "IGNITION" indication is shown on the ECAM memo display.

MANUAL SELECTION OF CONTINUOUS IGNITION

Continuous ignition may be manually selected when the engine is running by moving the ENG START rotary selector to IGN/START position.

AUTOMATIC SELECTION OF CONTINUOUS IGNITION

Continuous ignition is set by the EEC while the engine is running if the ENG ANTI ICE P/B is selected ON.
The EEC AUTOMATIC RELIGHT function energizes both igniters to give protection from an engine flame-out condition at idle. The automatic relight function is armed when the ENG MASTER switch is ON and the engine has started normally. The EEC then monitors the rate of change of N3 rotor speed at idle and compares it to a minimum datum calculated from the burner pressure (P30). If a flame-out condition is detected, both igniters are continuously energized until 10 seconds after normal engine operation is recovered.
The flight crew can initiate an engine QUICK RELIGHT in flight in order to quickly re-start the engine without any action on the ENG START rotary selector. This is done when the ENG MASTER switch is moved from OFF to ON within 30 seconds, and with N3 higher than 10%.
For the quick relight function, the EEC ignores the usual automatic start checks and the position of the ENG START rotary selector. It immediately opens the fuel metering valve and PRSOV and energizes both igniter plugs.

AUTOMATIC PROTECTION IN CASE OF RAIN/HAIL INGESTION

During bad weather conditions, the ingestion of large quantity of water and/or hail in the core engine can cause a sudden decrease of the burner temperature (T30), inducing a risk of engine flame-out. In such conditions, to prevent engine flame-out, the EEC energizes both igniter plugs to get continuous ignition.

NOTE: Note: that in addition, the EEC increases the N3 rotor speed in relation to T30 value and opens the core engine bleed valves to send the water into the by-pass casing.
Note: the rain/hail ingestion logic is not active on ground to avoid unwanted thrust increase while the aircraft is taxiing.

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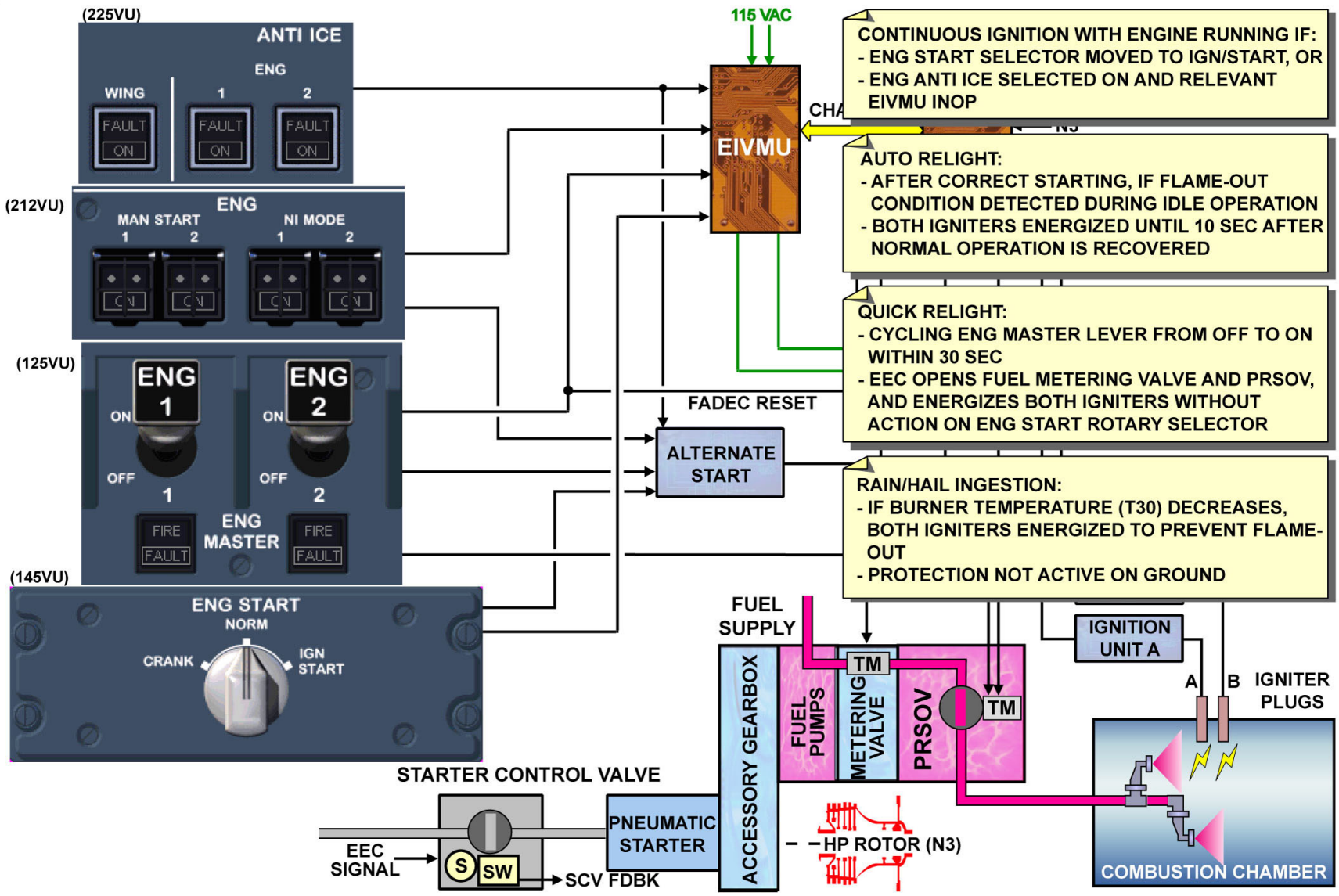

CONTINUOUS IGNITION OPERATION - MANUAL SELECTION OF CONTINUOUS IGNITION ... AUTOMATIC PROTECTION IN CASE OF RAIN/HAIL INGESTION

IGNITION AND STARTING D/O (3)

ENGINE SHUTDOWN

Engine shutdown is primarily controlled by closure of the PRSOV. The PRSOV is operated by a solenoid coil directly wired to the ENG/MASTER switch. The EEC also has the capability to shut off the fuel via the FMV when the engine enters the following modes:
- ground autostart, no light, stall, overtemperature,
- ground manual start with an excessive EGT,
- dual FMV position failures.

If the ENG/MASTER switch is cycled from the ON to the OFF, then to the ON position, the EEC will control the FMV and the ignition system to ON if the engine speed (N2) is above the flameout protection speed. If the engine is not running, the EEC will obey the pilot requested commands to do the engine starting logic.

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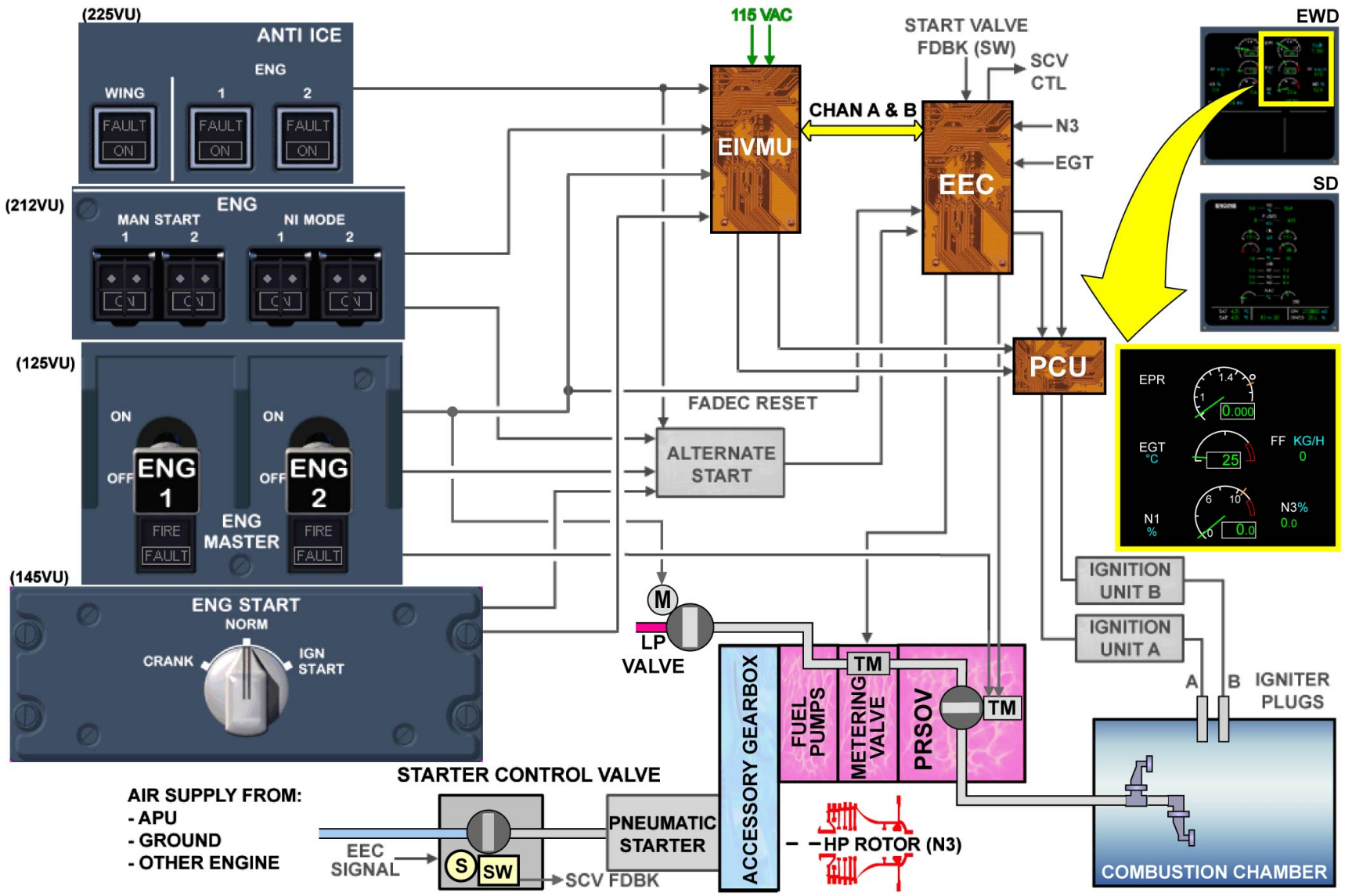

ENGINE SHUTDOWN

IGNITION AND STARTING D/O (3)

ENGINE MOTORING

The FADEC gives two modes of engine motoring: dry and wet. Mode selection is done by the EEC according to the EIVMU digital input which reflects cockpit settings.
A dry motoring sequence can be initiated with valid EIVMU data or via the alternate start logic circuit when the EIVMU data is invalid.
Wet motoring can only be initiated with valid EIVMU data.

DRY MOTORING

The engine dry motoring initial configuration is:
- ENG MASTER switch set to OFF position,
- ENG START rotary selector set to NORM position,
- electrical power available,
- air pressure available and above 30 psi.

To initiate dry motoring, set the ENG START rotary selector to the CRANK position. The EECs are then powered and the ENGINE system page comes up automatically on the ECAM SD, showing the SCV position and the bleed pressure available to the SCV.
When the ENG MAN START P/B is set to the ON position, the associated EEC controls the SCV to open by energizing its solenoid. The pneumatic starter rotates the N3 rotor.
Continuous operation of the pneumatic starter is limited; the starter cycle must not exceed 5 minutes.
It is possible to interrupt the dry motoring procedure at any time by releasing out the ENG MAN START P/B.

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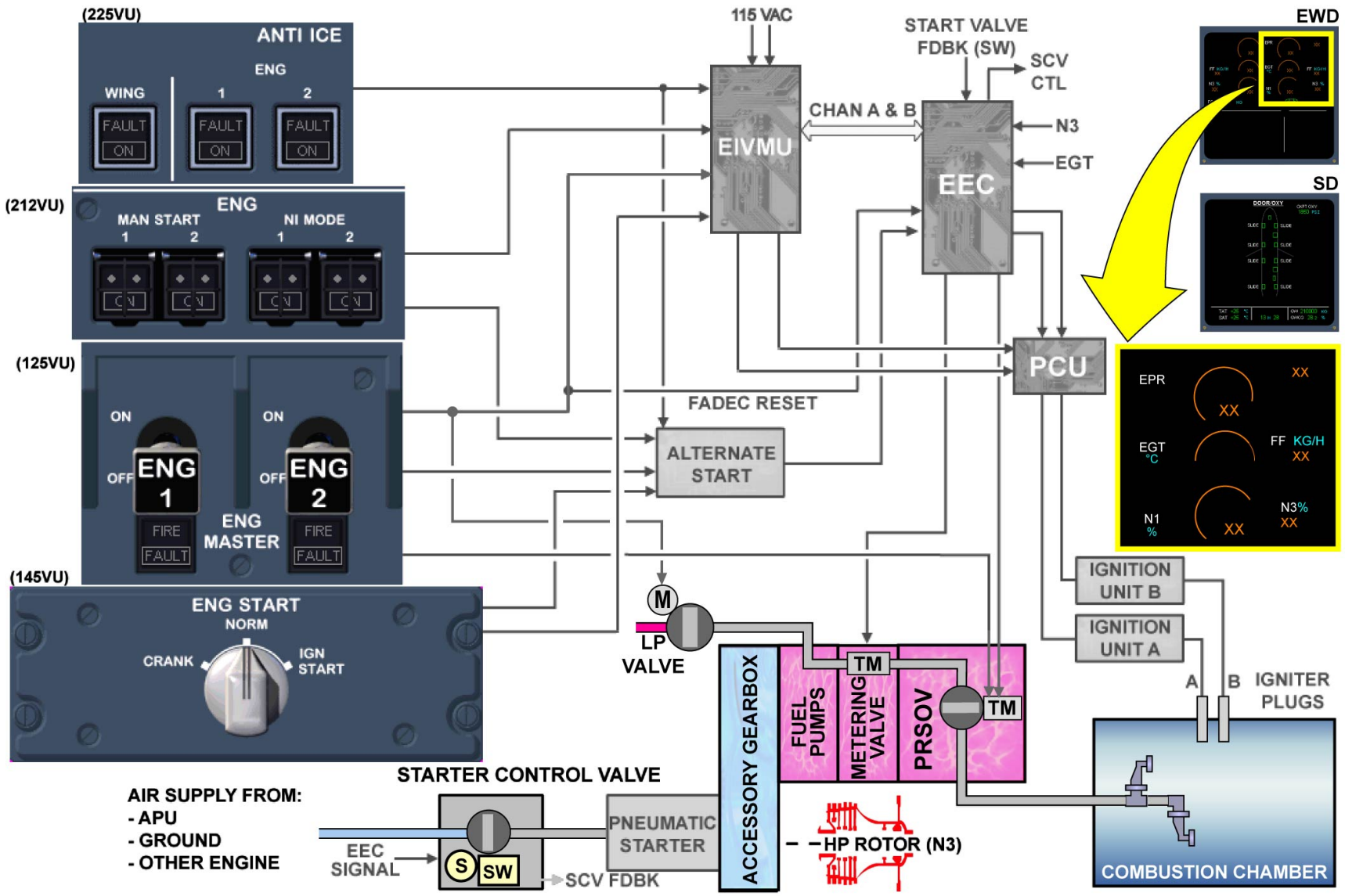

ENGINE MOTORING - DRY MOTORING

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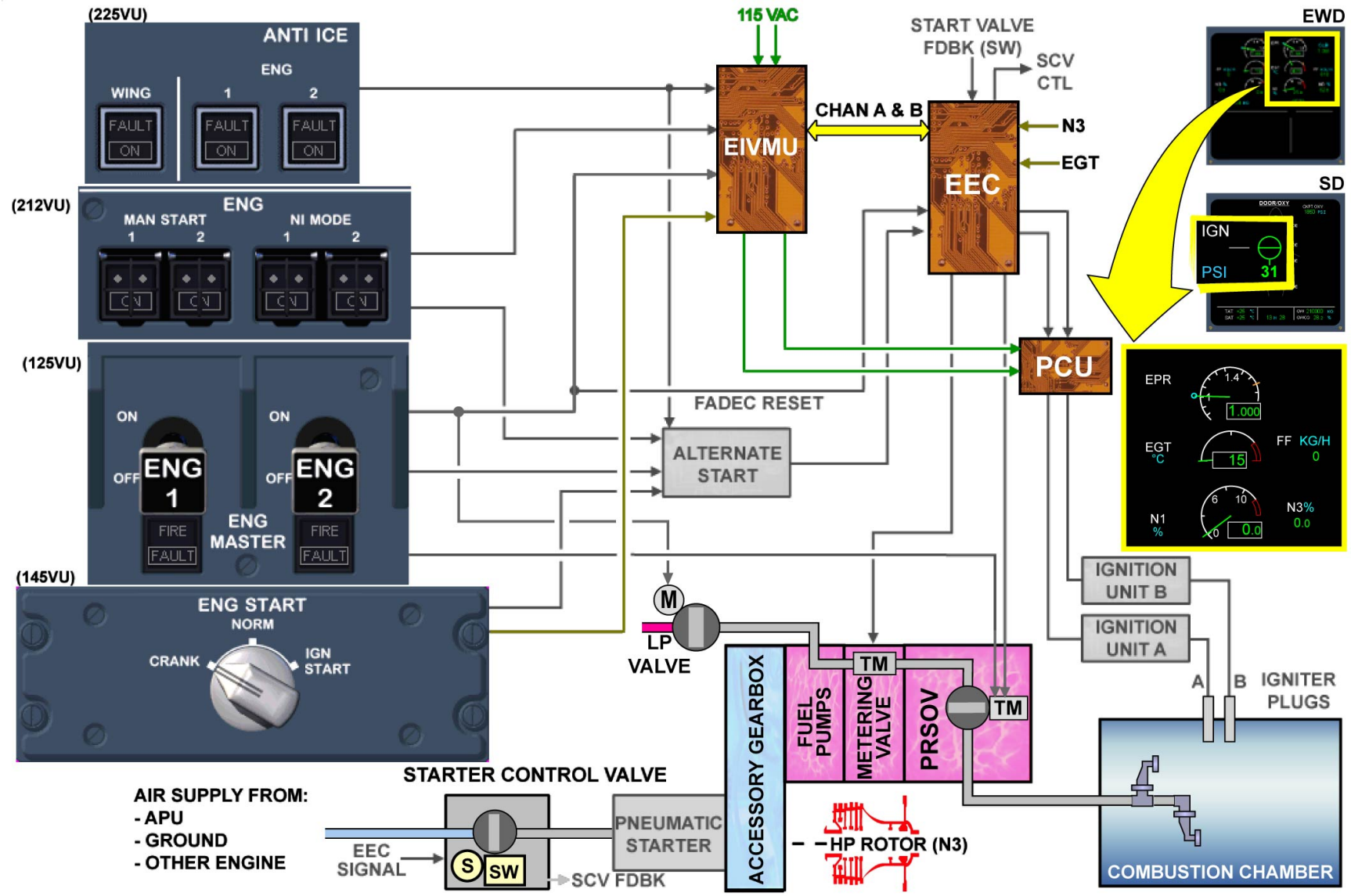
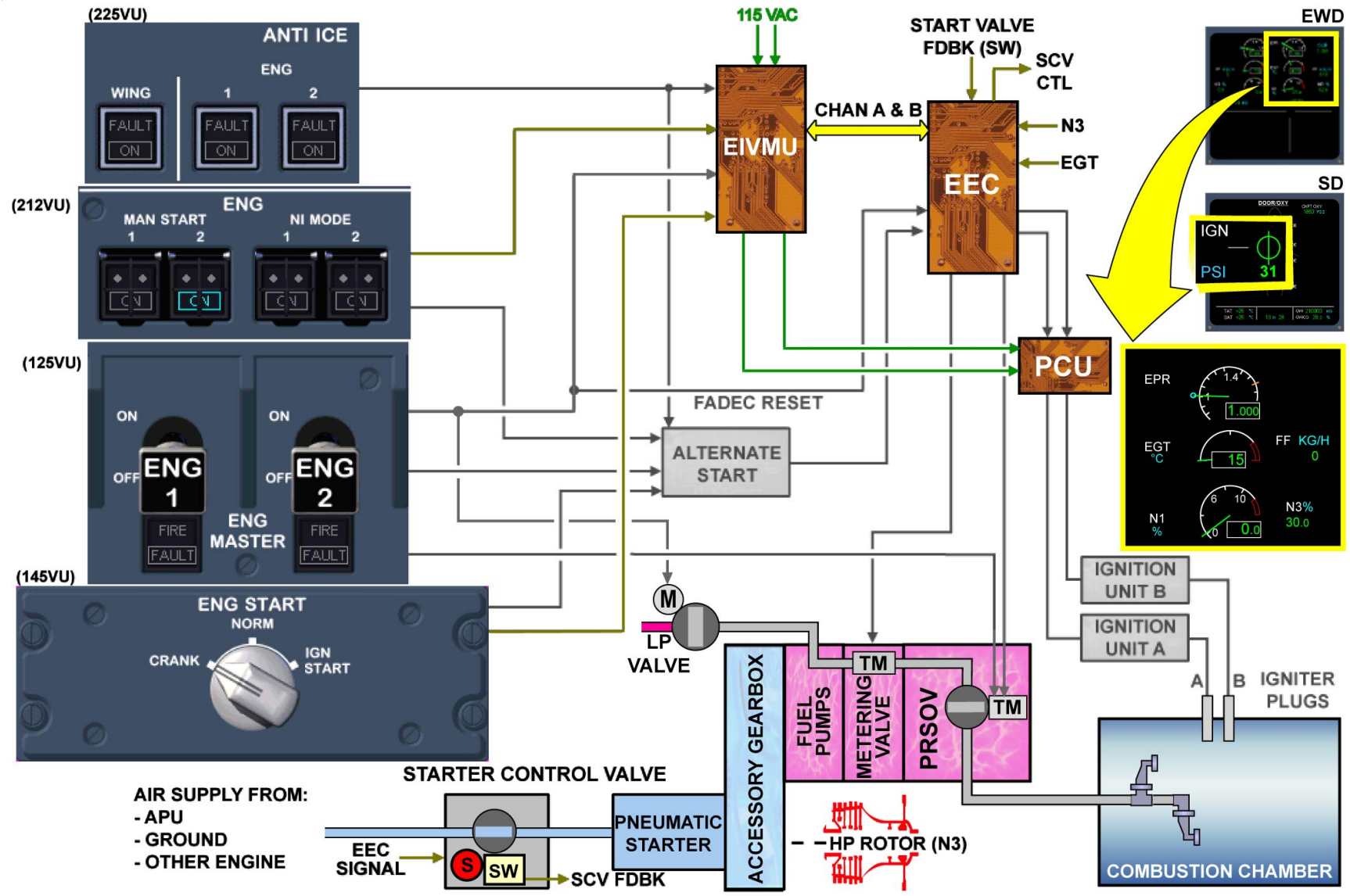
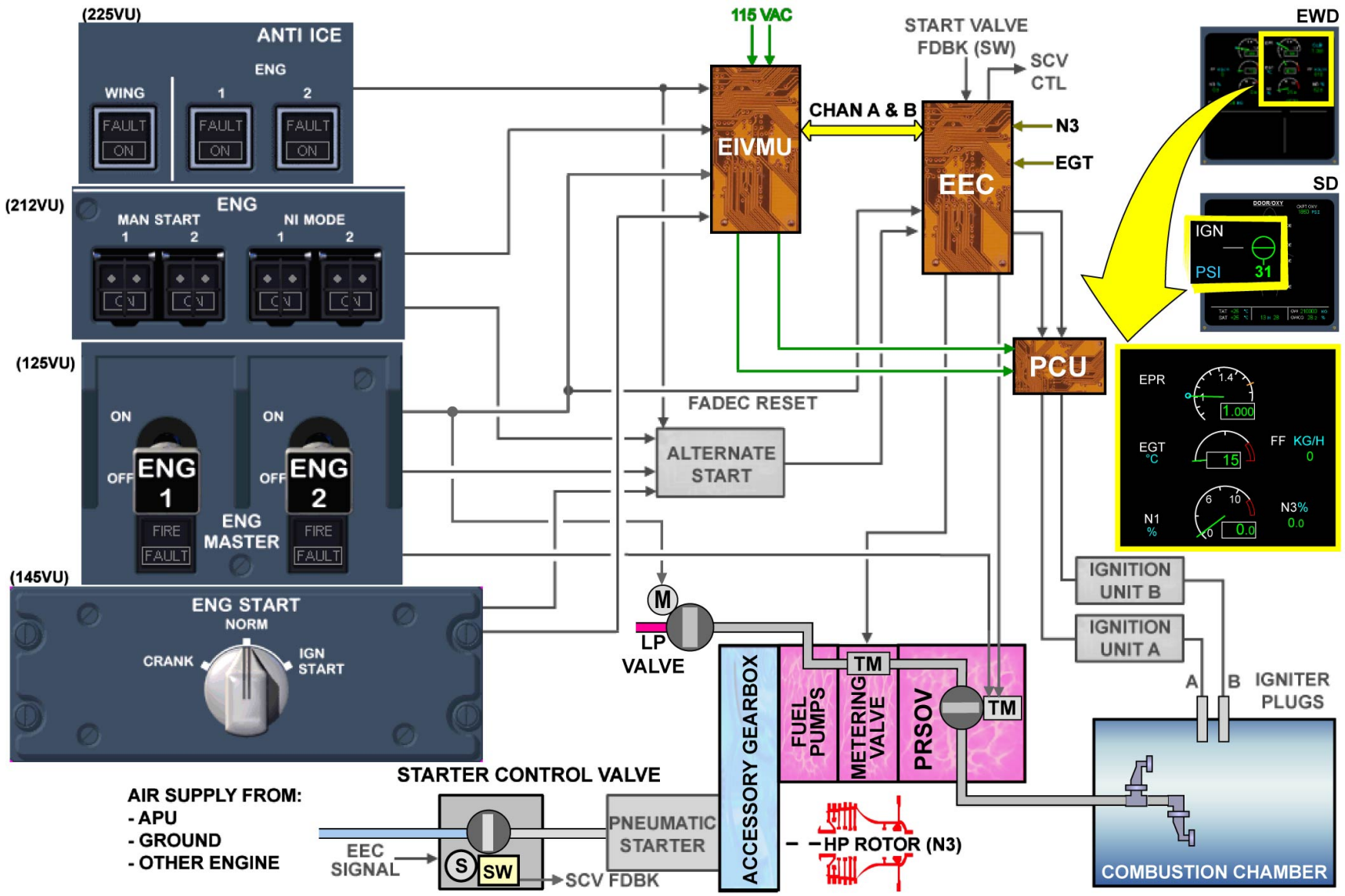


ENGINE MOTORING - DRY MOTORING



ENGINE MOTORING - DRY MOTORING



ENGINE MOTORING - DRY MOTORING

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IGNITION AND STARTING D/O (3)

ENGINE MOTORING (continued)

WET MOTORING

The engine wet motoring initial configuration is the same as for the dry motoring initial configuration, but with engine fuel supply available and the engine ignition C/Bs pulled for safety.
To initiate wet motoring, set the ENG START rotary selector to the CRANK position. The EECs are then powered and the ENGINE system page comes up automatically on the ECAM SD, showing the SCV position and the bleed pressure available to the SCV.
When the ENG MAN START P/B is set to ON position, the associated EEC controls the SCV to open by energizing its solenoid. The pneumatic starter rotates the N3 rotor.
When N3 reaches at least 20%, the associated ENG MASTER switch has to be selected ON. Then, the EEC commands the fuel supply by opening the metering valve and the PRSOV.
After fuel flow confirmation, selecting the ENG MASTER switch to OFF stops the fuel flow and initiates a dry motoring procedure.
The engine continues to motor without fuel supply to allow the combustion chamber to dry out. The wet motoring sequence can be aborted by placing the ENG MANual START P/B switch in the OFF position or by moving the ENG START rotary selector back to the NORM position.

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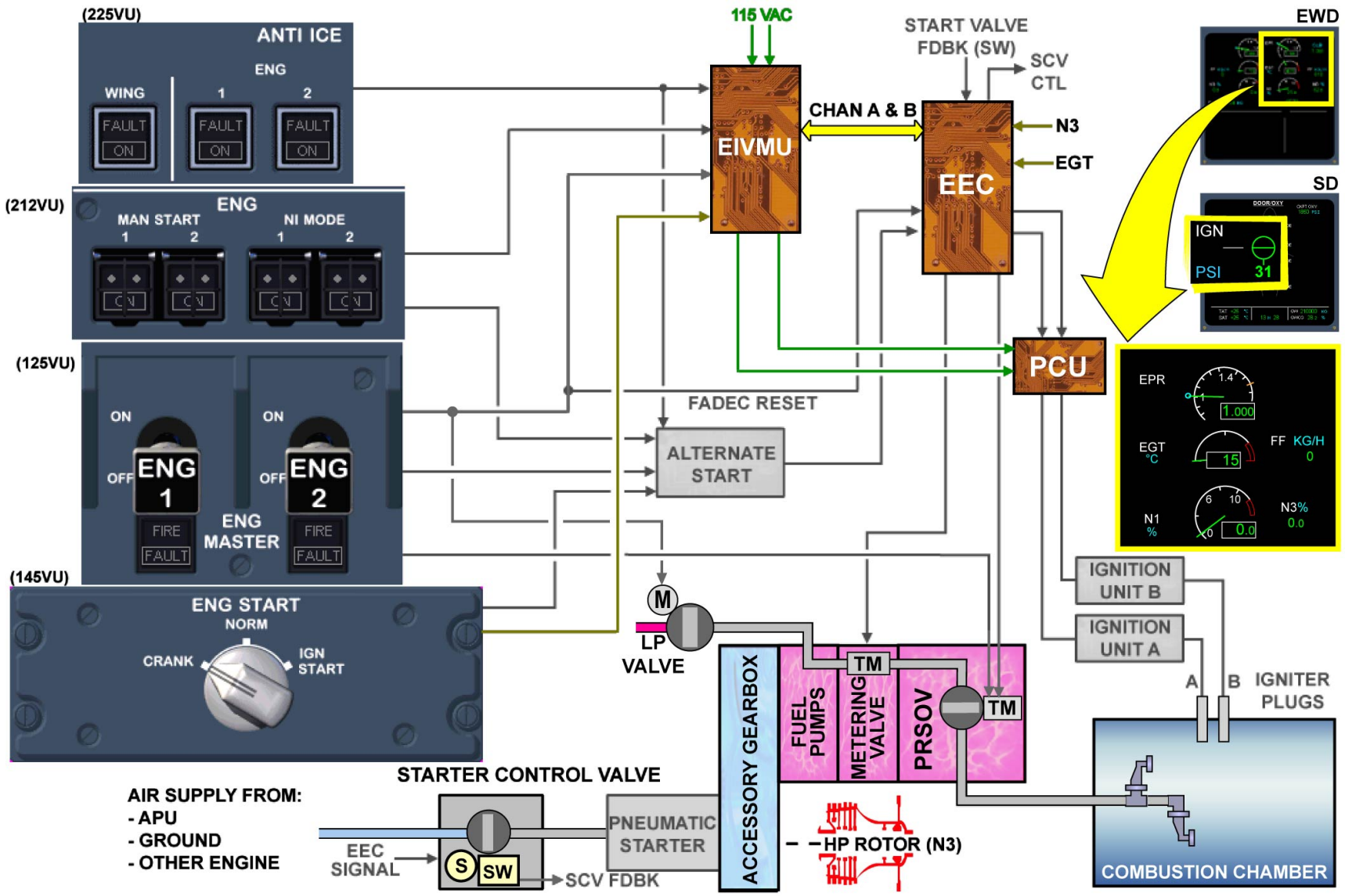
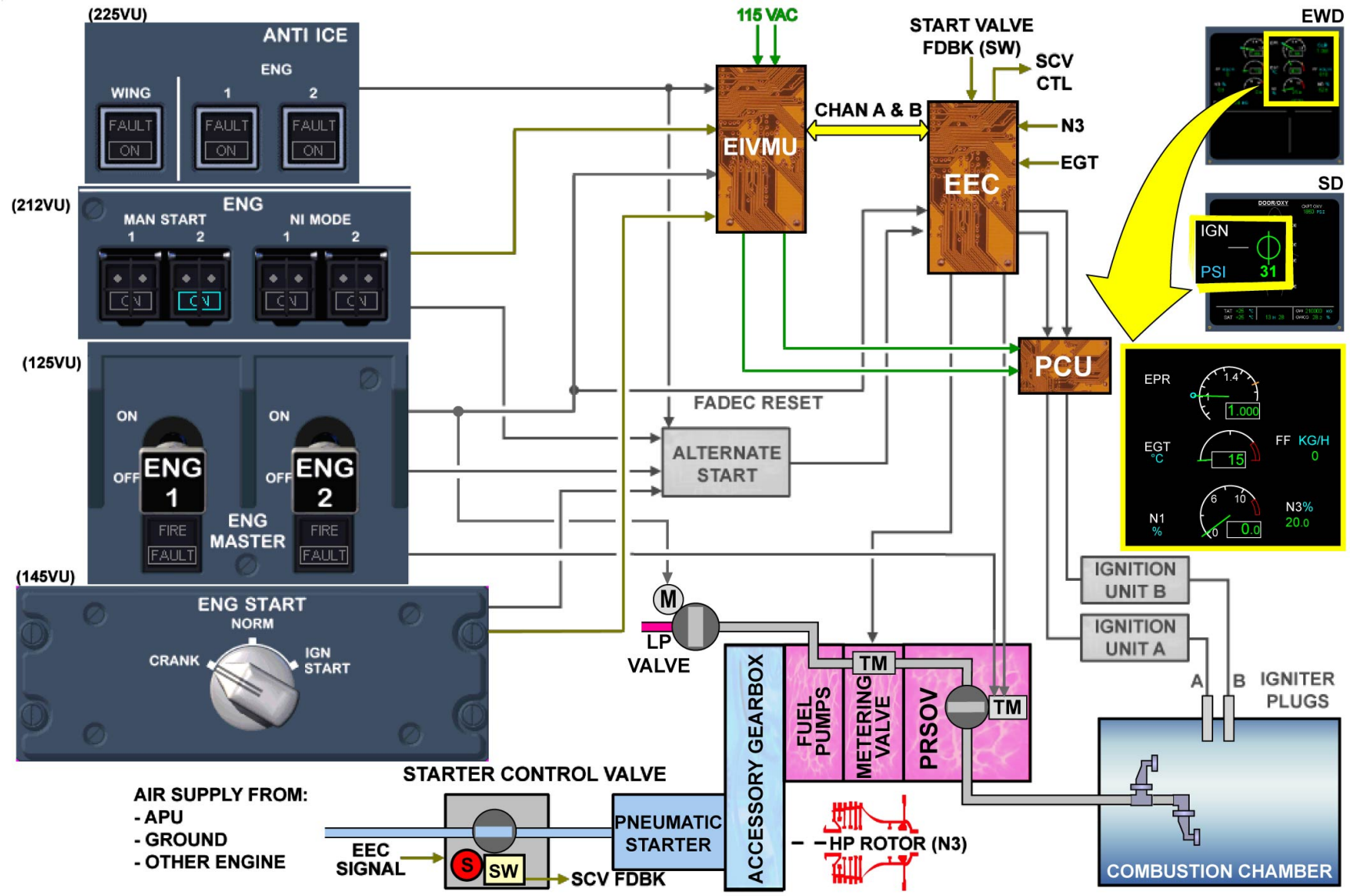
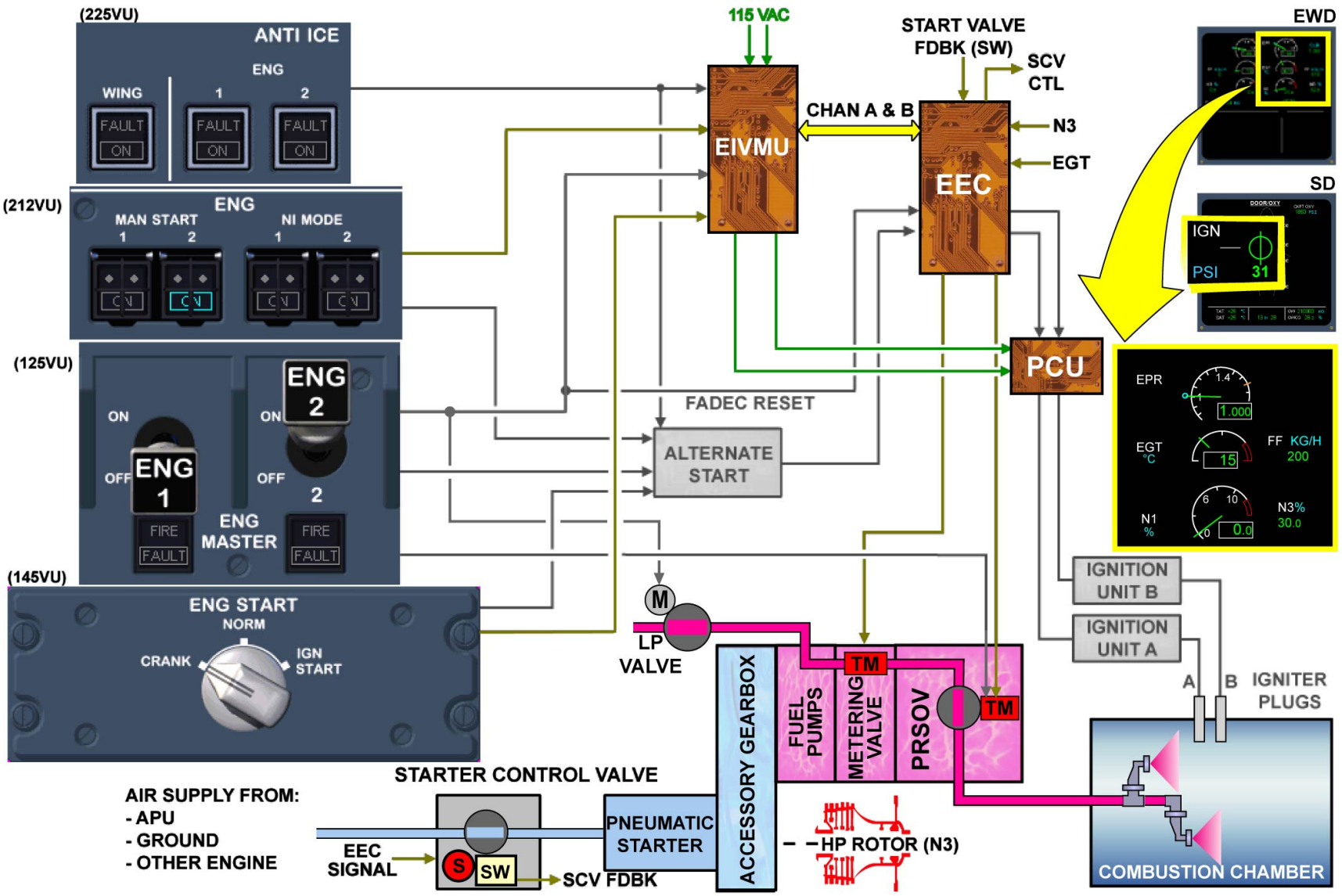


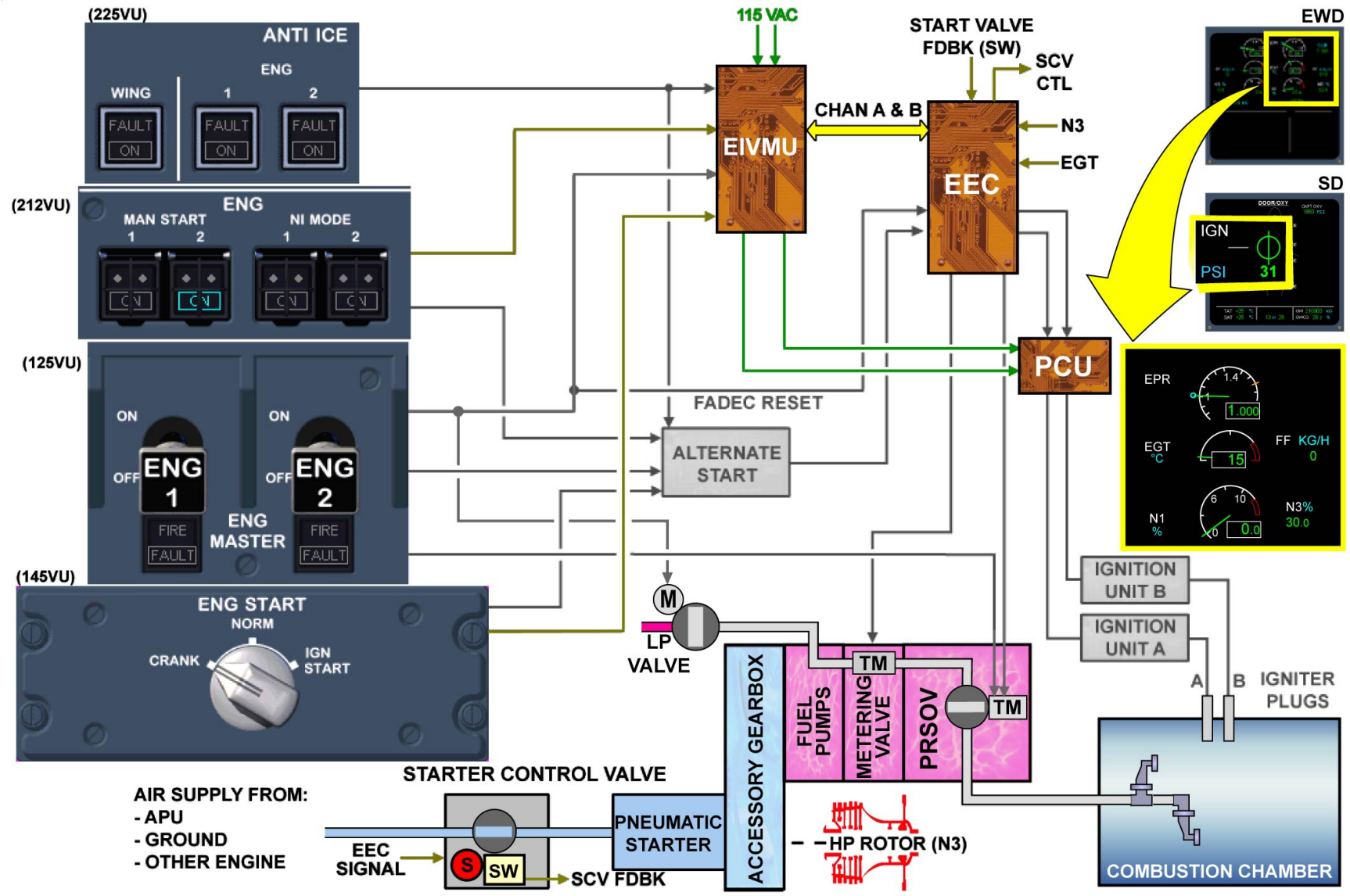
ENGINE MOTORING - WET MOTORING



ENGINE MOTORING - WET MOTORING



ENGINE MOTORING - WET MOTORING



ENGINE MOTORING - WET MOTORING

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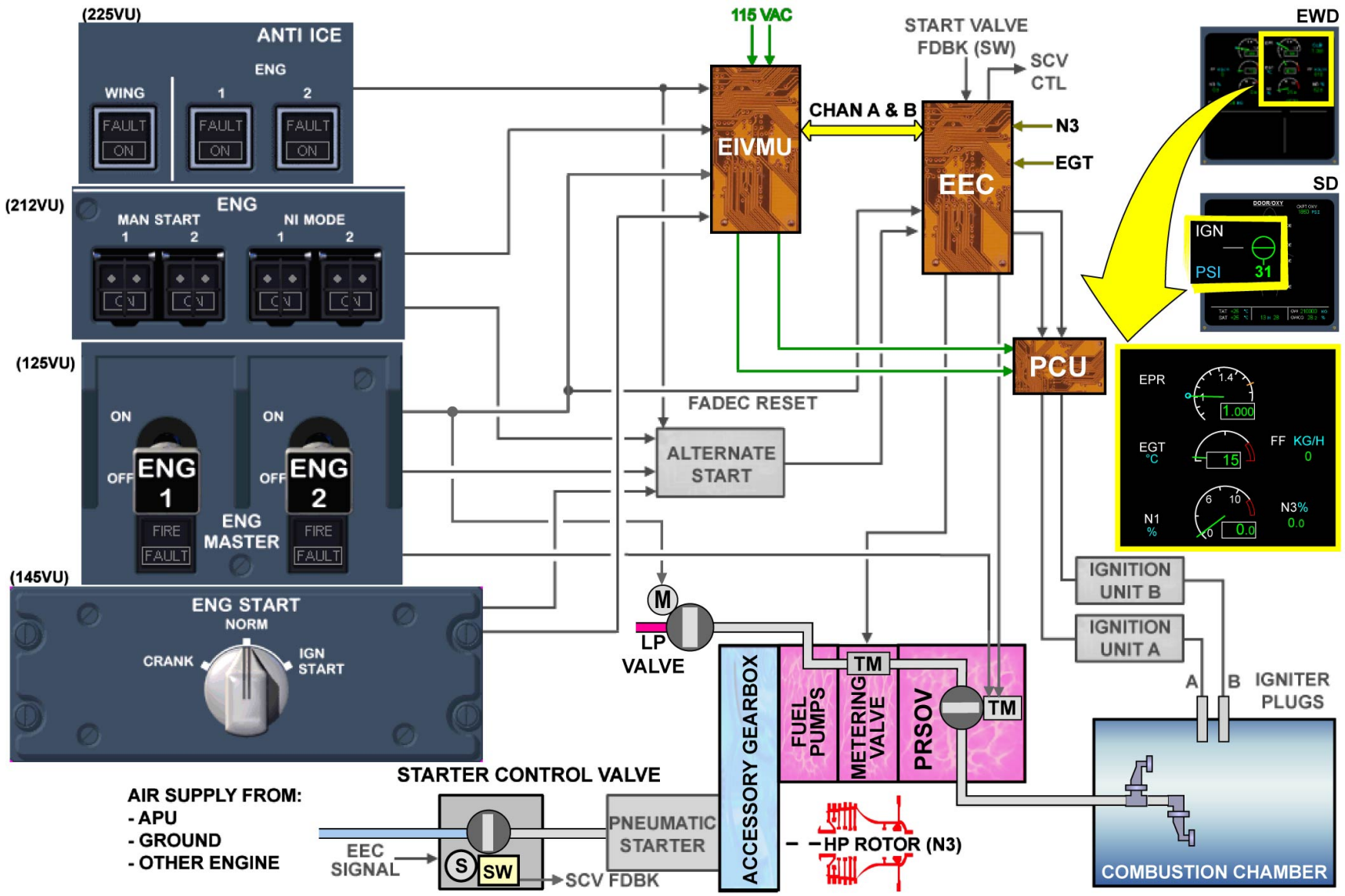

ENGINE MOTORING - WET MOTORING

AIRFLOW CONTROL SYSTEM D/O (3)

GENERAL

The function of the airflow control system is to fulfill a stable airflow through the Intermediate Pressure (IP) and High Pressure (HP) compressors at any thrust ranges to avoid engine stall or surge. It also controls the volume of airflow through the IP and HP compressors.
To control the airflow, the system uses:
- Variable Inlet Guide Vanes (VIGVs) and two stages of IP compressor Variable Stator Vanes (VSVs),
- four IP bleed valves in line with stage 8 of the IP compressor,
- three HP bleed valves in line with stage 3 of the HP compressor.

The airflow control system is controlled by the Engine Electronic Controller (EEC).

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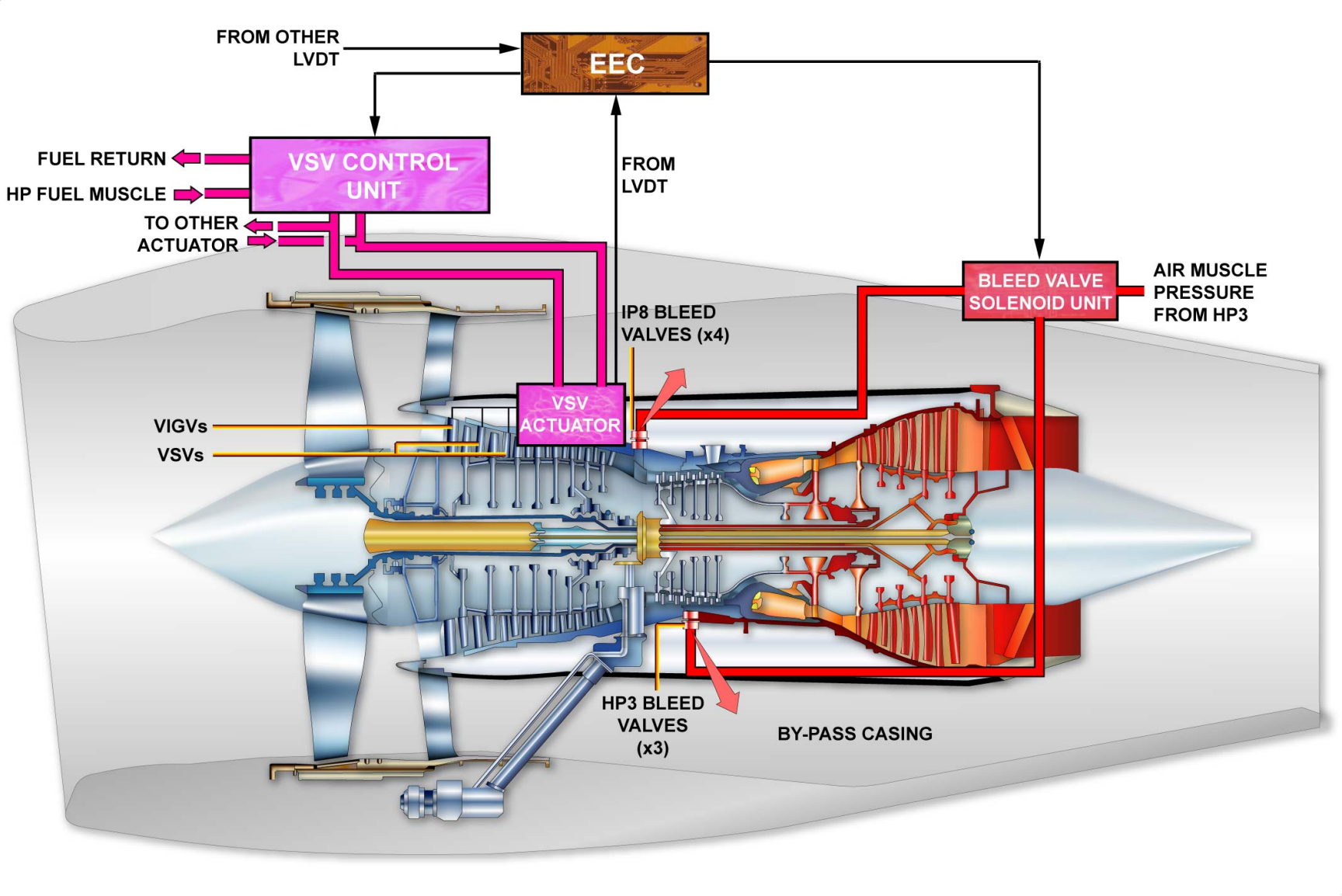
FROM OTHER LVDT
EEC
FUEL RETURN
HP FUEL MUSCLE
VSV CONTROL UNIT
TO OTHER ACTUATOR
FROM LVDT
BLEED VALVE SOLENOID UNIT
AIR MUSCLE PRESSURE FROM HP3
IP8 BLEED VALVES (x4)
VSV ACTUATOR
VIGVs
VSVs
HP3 BLEED VALVES (x3)
BY-PASS CASING

GENERAL

AIRFLOW CONTROL SYSTEM D/O (3)

VIGV/VSV DESCRIPTION

The IP compressor VIGV/VSV system includes:
- one VSV control unit,
- two VSV actuators,
- VIGV/VSV actuating mechanism.

VSV CONTROL UNIT

The VSV control unit is used to control the VSV actuators position using fuel servo pressure. It is installed on the lower left side of the compressor intermediate case.
The VSV control unit mainly has a torque motor and a control servo valve which control the flow of servo fuel to and from the VSV actuators.

VSV ACTUATORS

Two VSV actuators are installed 180 degrees apart on each side of the engine horizontal center line. Each actuator controls the movement of the VIGVs and VSVs through the VIGV/VSV actuating mechanism. They are actuated by servo fuel pressure from the VSV control unit. When the actuator retracts, the VSVs open and when it extends, the VSVs close.
Each actuator has a Linear Variable Differential Transducer (LVDT) for position feedback.
The LH actuator sends the LVDT information to EEC channel A and, respectively, the RH actuator sends the LVDT information to EEC channel B.
Each actuator also has a fuel drain tube.

VIGV/VSV ACTUATING MECHANISM

The VIGV/VSV actuating mechanism is installed around the LP/IP bearing support assembly and the IP compressor case.
It changes the linear movement of the actuator to the angular movement of the VIGVs and VSVs.

This actuating system includes rods, bellcranks and unison rings.

VIGV/VSV OPERATION

The VIGVs and VSVs are adjusted during starting, acceleration, deceleration and surge conditions to maintain the correct operation of the IP and the HP compressors.
The EEC uses IP compressor shaft speed (N2) and the IP compressor inlet temperature (T24) signals to control the angular position of the VIGVs and VSVs. If these signals are not available the EEC uses signals based on a pressure ratio to control the VIGVs and VSVs.
Each LVDT sends its actuator position feedback to a different EEC channel.
If a failure of the electrical supply occurs, the VIGVs and VSVs are moved to their failsafe position (closed position), corresponding to a low speed position.

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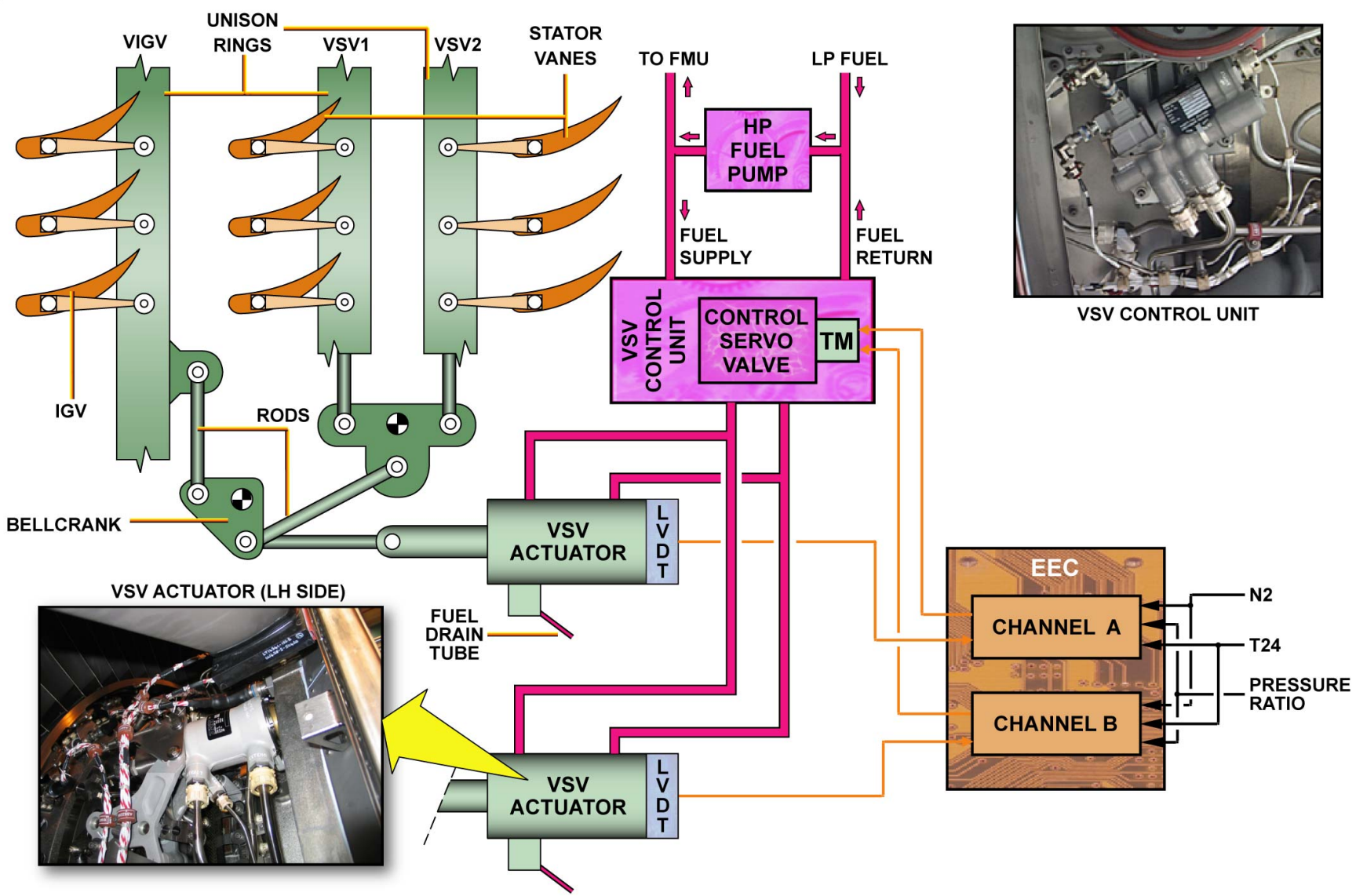

VIGV/VSV DESCRIPTION & VIGV/VSV OPERATION

AIRFLOW CONTROL SYSTEM D/O (3)

IP & HP BLEED VALVES DESCRIPTION

Seven bleed valves are installed around the IP and HP compressor. These valves are controlled via a bleed valve solenoid unit.

IP & HP BLEED VALVES

Four IP bleed valves are installed on and around the compressor intermediate case and aligned with stage 8 of the IP compressor.
Three HP bleed valves are installed near the front of the combustion outer case and aligned with stage 3 of the HP compressor.
Two HP bleed valves, HP3.3 and HP3.2, are installed at the top right and bottom right of the case.
The third one, HP3.1, is located at the bottom left of the case.
Each IP/HP bleed valve has a perforated silencer/seal assembly that seals the valve against the flat inner surface of the thrust reverser cowl.
The silencer goes through an opening in the thrust reverser cowl to discharge the compressor air in the fan stream.
The valves have internal chambers and springs for operation and are supplied with HP3 air muscle pressure from the bleed valve solenoid unit through its solenoid valves.

BLEED VALVE SOLENOID UNIT

The bleed valve solenoid unit is composed of five solenoid valves attached together to make one unit and it is installed on RH side in front of the compressor intermediate case.
Access is gained by opening the thrust reverser cowls and removing the right center gas generator fairing.
The four IP bleed valves are operated in pairs by two of the solenoid valves. The three HP bleed valves are operated by the remaining three solenoid valves.
The bleed valve solenoid unit has a pneumatic connector for HP3 air supply with two electrical connectors for EEC channel A and B electrical control.

Each solenoid valve has two coils: one linked to EEC channel A and the other to channel B. It can supply or stop HP3 servo air to open or close a bleed valve.

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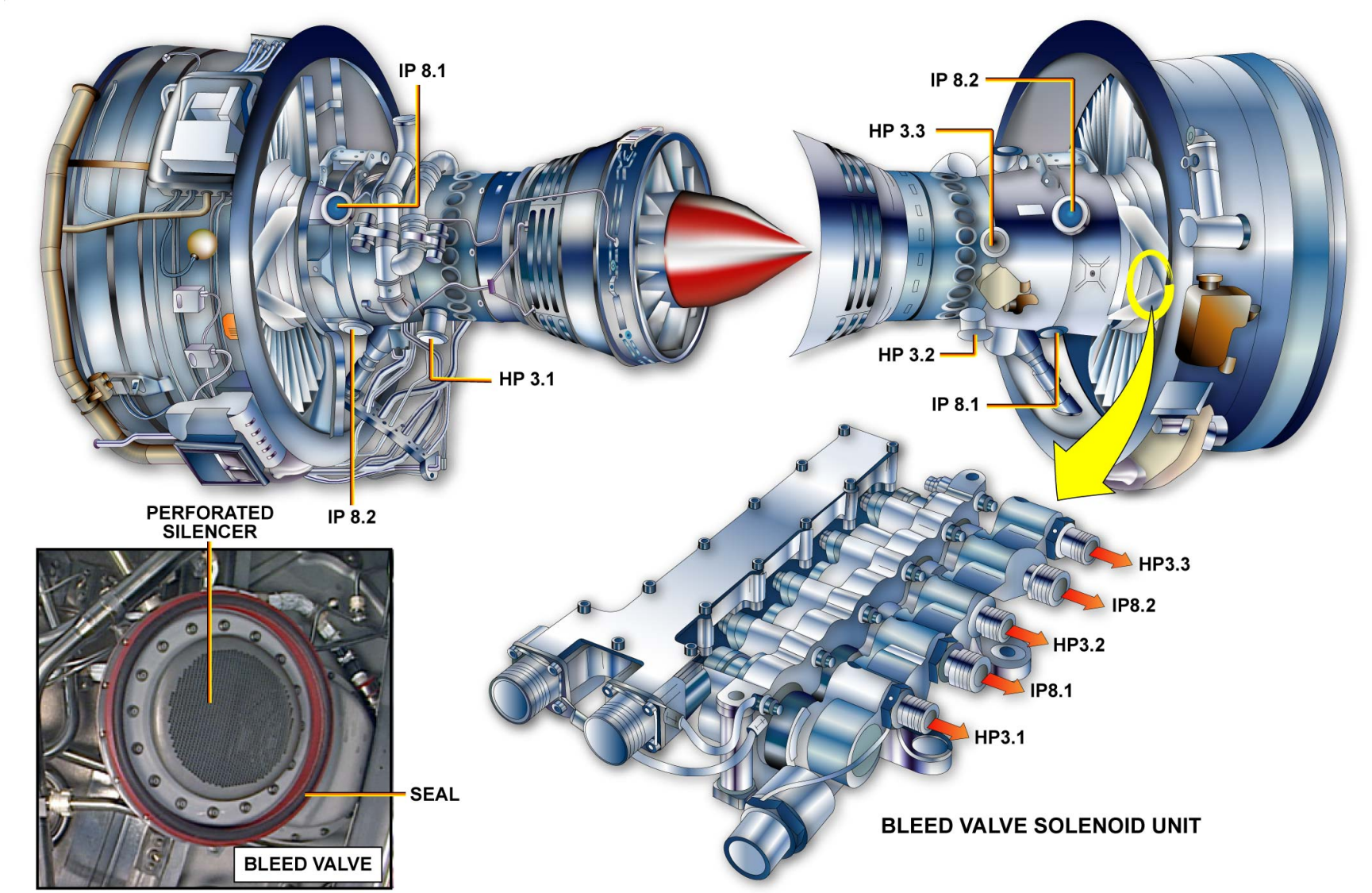

IP & HP BLEED VALVES DESCRIPTION - IP & HP BLEED VALVES & BLEED VALVE SOLENOID UNIT

AIRFLOW CONTROL SYSTEM D/O (3)

IP & HP BLEED VALVES OPERATION

IP and HP bleed valves are controlled to open during engine starting, at low engine speed and during specific conditions.
They are used to discharge a proportion of IP or HP compressor air into the engine by-pass casing.
The scheduling of the bleed valves is computed by the EEC and controlled through the bleed valve solenoid unit.
Each solenoid valve is connected to both channels of the EEC.
Each valve is independently operated as a function of N2 and IP compressor inlet temperature (T24) for the IP bleed valves, and as a function of N3 and T24 for the HP bleed valves. If these signals are not available the EEC uses signals based on a pressure ratio.
The EEC can also use signals from the Throttle Resolver Angle (TRA) to set each bleed valve.
When one HP/IP bleed valve solenoid is de-energized, HP3 air muscle pressure forces the corresponding valve to open in addition to the spring load.
When the solenoid is energized, HP3 air from the servo chamber is released through the solenoid valve. This lets the compressor air pressure close the bleed valves.
With no electrical control signal, the bleed valves are maintained in the open position by spring load.

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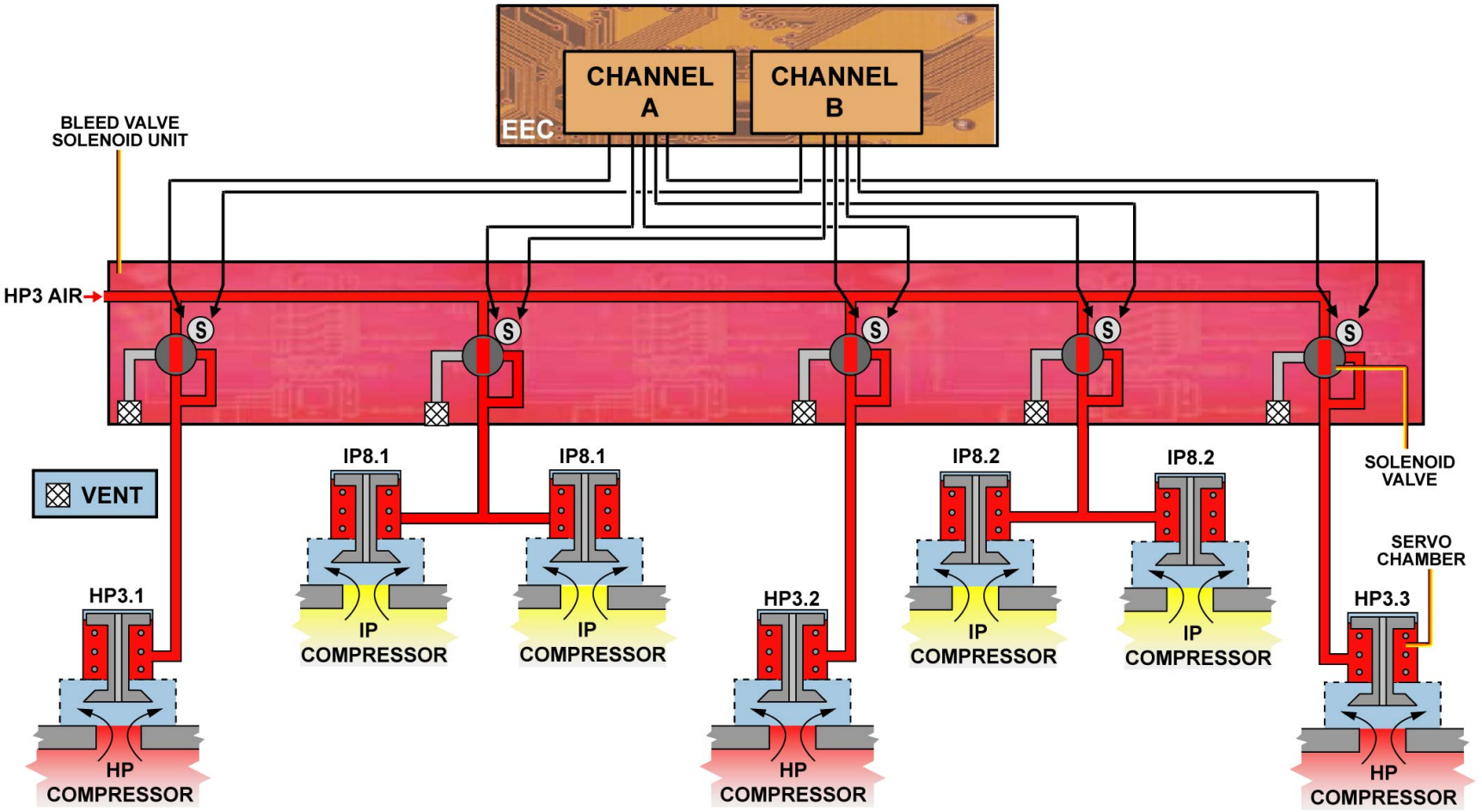
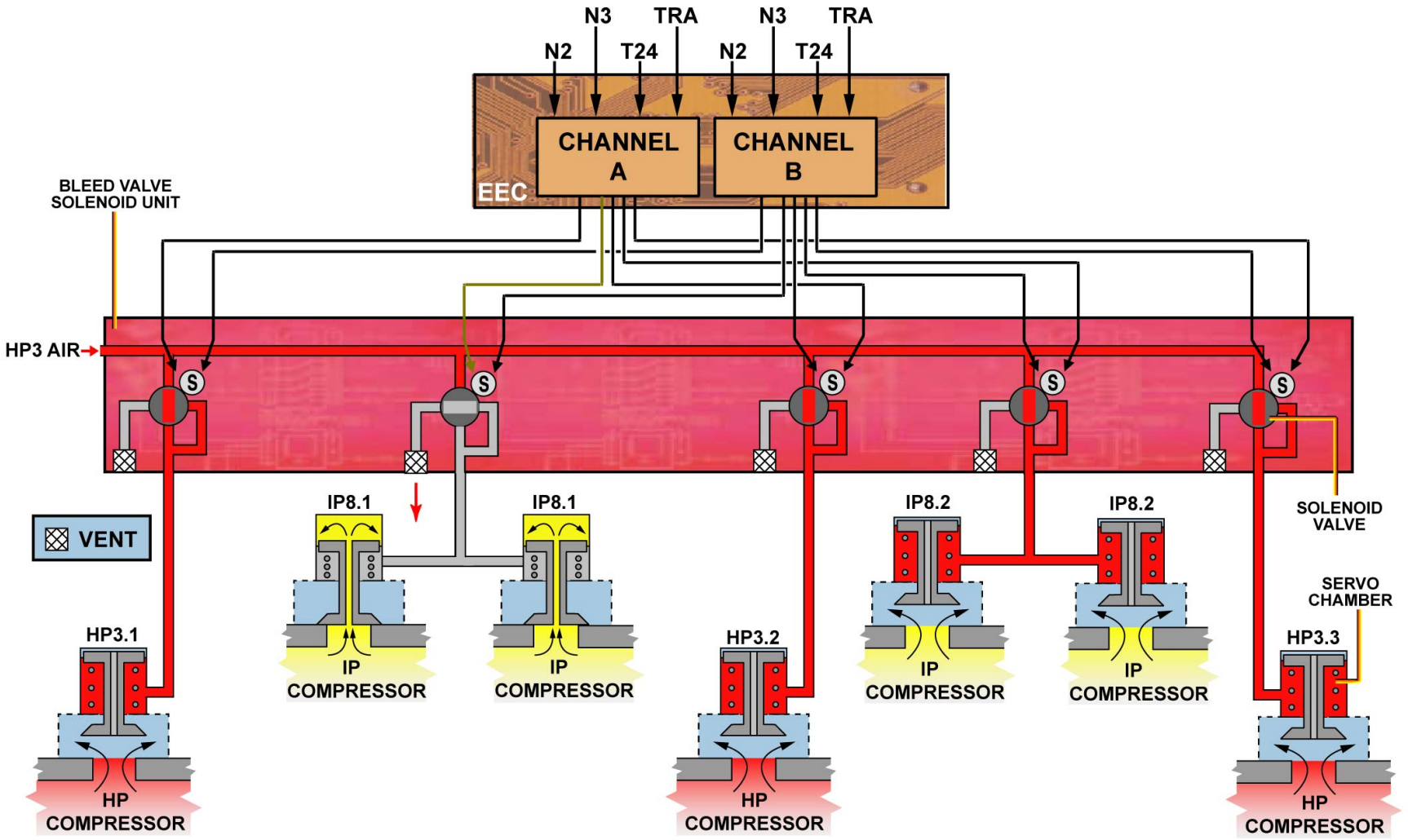


IP & HP BLEED VALVES OPERATION



IP & HP BLEED VALVES OPERATION

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ENGINE COOLING SYSTEM D/O (3)

GENERAL

Air is supplied from different sources to decrease the engine temperature through internal and external cooling. The air used to cool and pressurize the different engine compartments is supplied through external tubes and through internal passages. Internal compartments that are at different pressures are isolated from each other by labyrinth seals. For cooling, the nacelle is divided into 3 different zones. Cooling airflow is also provided for the Full Authority Digital Engine Control (FADEC) electronic units, located in the electronic unit protection box.

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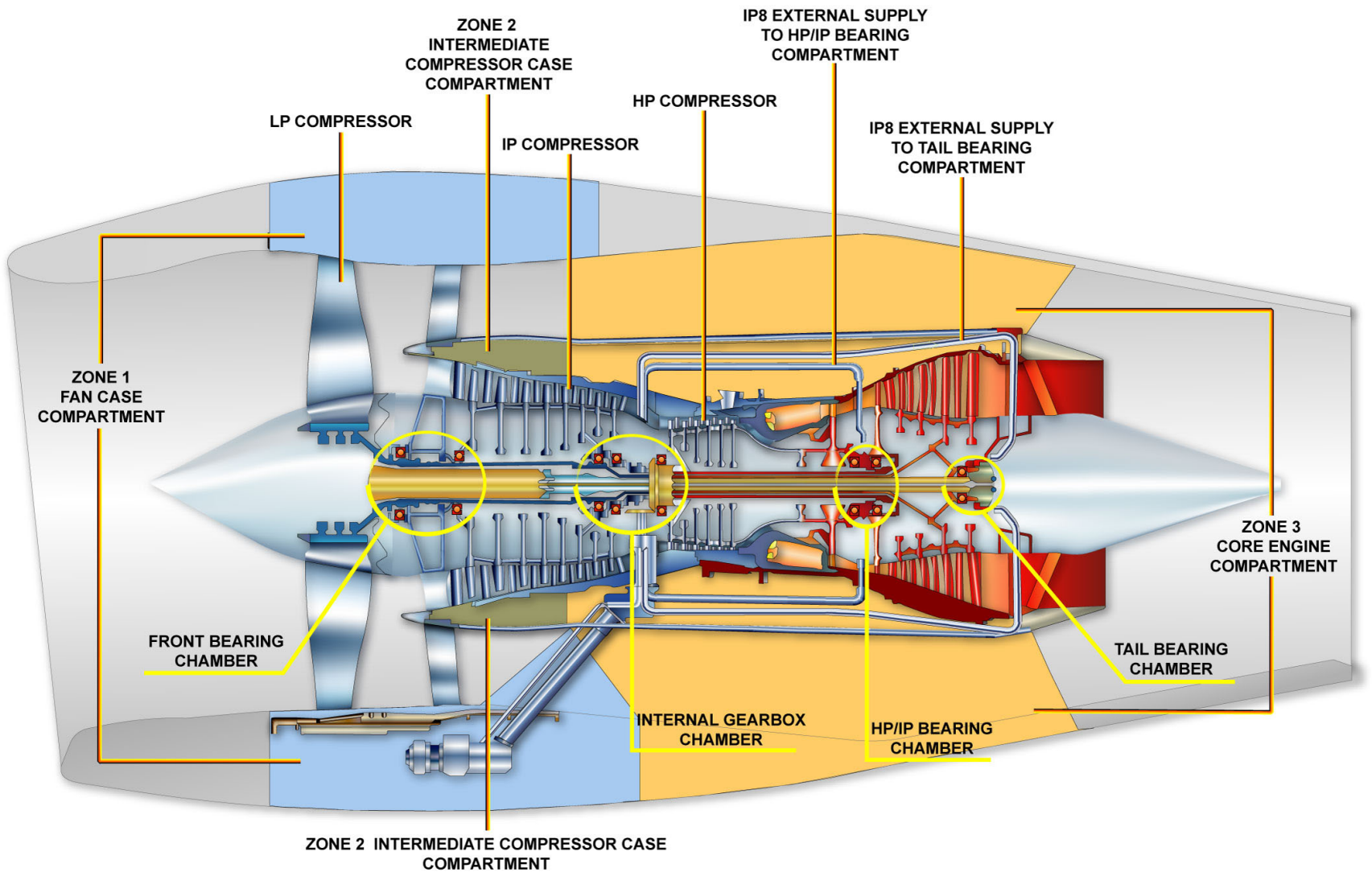
ZONE 2
INTERMEDIATE
COMPRESSOR CASE
COMPARTMENT
IP8 EXTERNAL SUPPLY
TO HP/IP BEARING
COMPARTMENT
HP COMPRESSOR
LP COMPRESSOR
IP COMPRESSOR
IP8 EXTERNAL SUPPLY
TO TAIL BEARING
COMPARTMENT
ZONE 1
FAN CASE
COMPARTMENT
ZONE 3
CORE ENGINE
COMPARTMENT
FRONT BEARING
CHAMBER
TAIL BEARING
CHAMBER
INTERNAL GEARBOX
CHAMBER
HP/IP BEARING
CHAMBER
ZONE 2 INTERMEDIATE COMPRESSOR CASE
COMPARTMENT

GENERAL

ENGINE COOLING SYSTEM D/O (3)

NACELLE COOLING D/O

The powerplant is divided into three primary fire-resistant zones isolated from each other by fireproof bulkheads and seals. These zones are supplied with cooling airflow in order to:
- keep the temperature in the cowls at a satisfactory level,
- decrease the temperature of the main fuel and oil accessory units,
- prevent the accumulation of hazardous vapours.

Zone 1 - Fan Case Compartment:
The zone 1 is ventilated by ram air ducted through an opening on top of the air intake cowl, The ventilation air is exhausted through an opening in the lower part of the right hand fan cowl door.
Zone 2 - Intermediate Compressor Case Compartment:
The zone 2 is ventilated by air from the LP compressor that enters through two holes at the top rear of the zone and then flows around the zone. The ventilation air is exhausted at the bottom of the zone into the by-pass casing through two holes in the front of the engine core fairings.
Zone 3 - Core Engine Compartment:
The zone 3 is ventilated by air from the LP compressor that enters through ducts in the inner fixed structure of the 'C' ducts. The ventilation air is exhausted through an exit at the bottom of the 'C' duct longitudinal beam.
At the bottom of the core engine, in the front flange of the combustion outer case, there is a thermocouple probe installed and electrically connected to the EEC for Nacelle temperature indicating function.
Nacelle temperature is indicated:
- in green color in normal operation
- in green pulsing color if the temperature exceeds 260 DEG.C (500 DEG.F) (High nacelle temperature advisory).

A separate fire-resistant and cooling zone is the electronic unit protection box installed on the left fan case. The following FADEC electronic boxes are installed inside a protection box:
- the Engine Electronic Controller (EEC),
- the Power Control Unit (PCU),
- the Overspeed Protection Unit (OPU).

The ventilation and cooling of the protection box is done by using external air from the air intake cowl that is ducted across the LP compressor case to the protection box.
The cooling air flows out from the protection box and is ducted to the inlet of the LP compressor.

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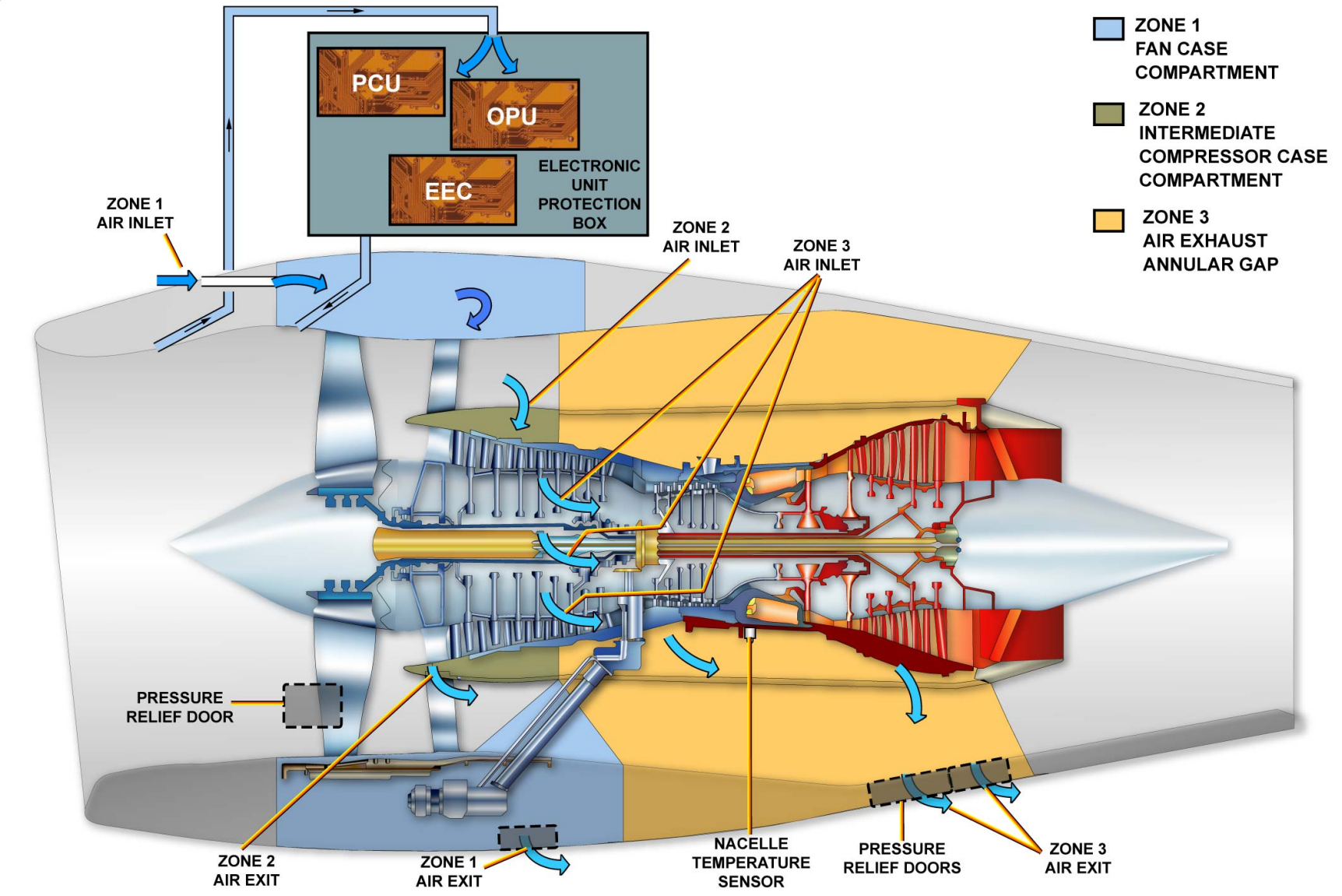
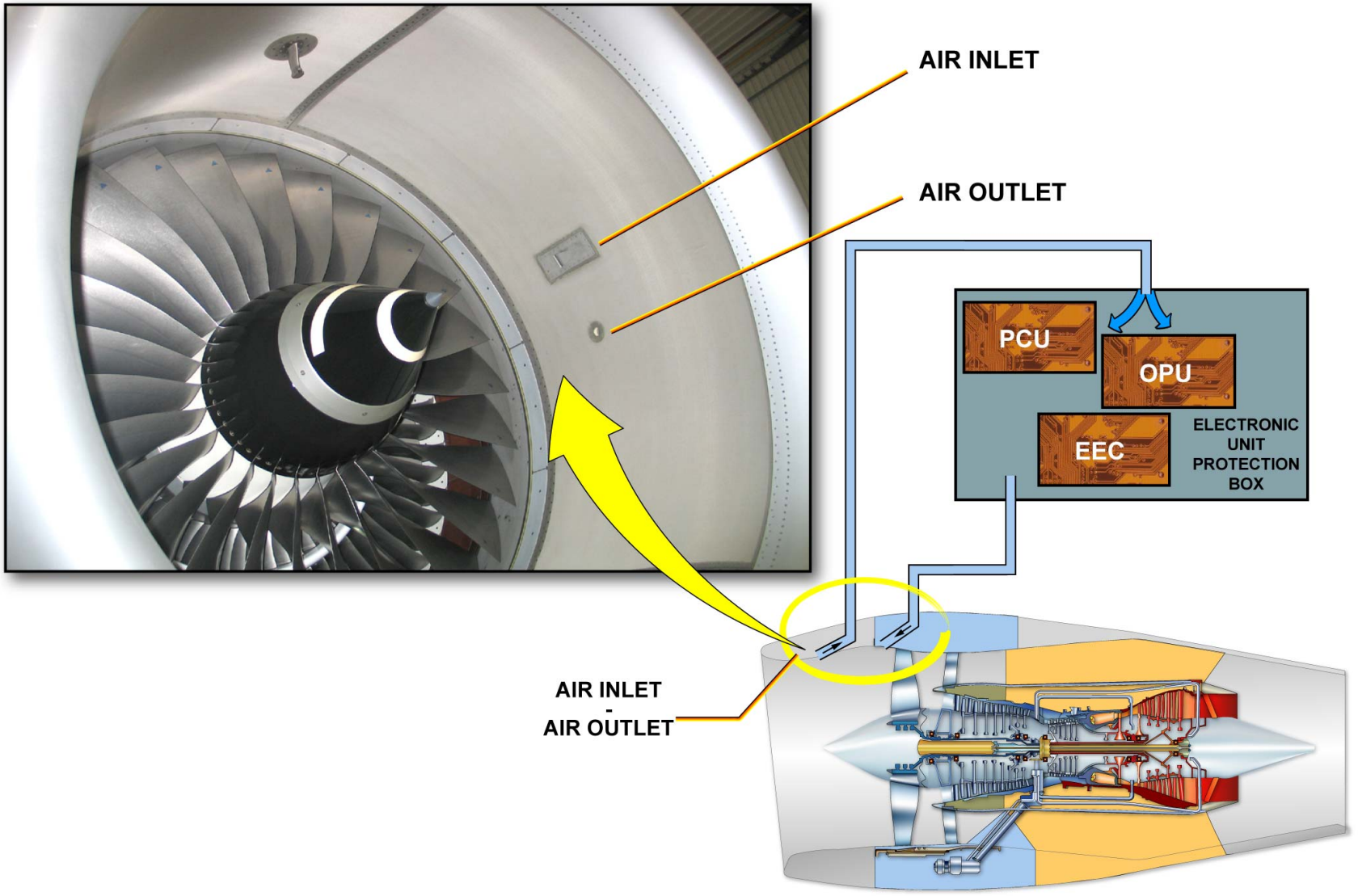


NACELLE COOLING D/O



NACELLE COOLING D/O

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ENGINE COOLING SYSTEM D/O (3)

TURBINE IMPINGEMENT COOLING (TIC) D/O

The TIC system is designed to maximize the turbine efficiency. During engine operation, the turbine cases heat up and expand at a higher rate than the turbine blades. This expansion increases the blade tip clearance. The TIC system supplies fan air to both the IP and LP turbine cases to control the IP turbine blade tip clearances and cool the LP case. The TIC valve is controlled by the EEC.

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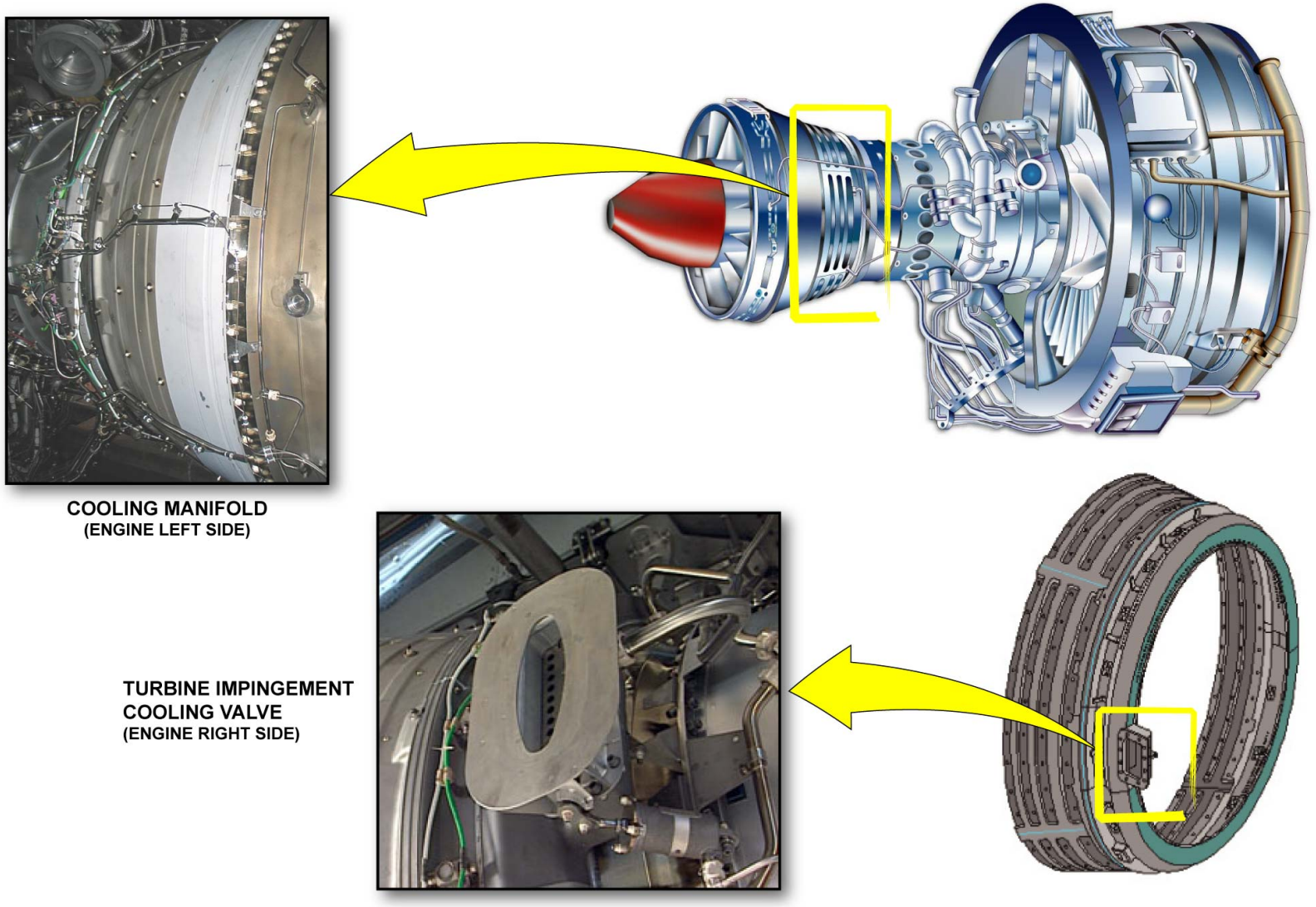

TURBINE IMPINGEMENT COOLING (TIC) D/O

ENGINE COOLING SYSTEM D/O (3)

TURBINE IMPINGEMENT COOLING (TIC) D/O (continued)

DESCRIPTION

The TIC system is composed of:
- a solenoid valve,
- an actuating ram,
- the TIC valve,
- a coolingmanifold.

OPERATION

The solenoid valve is attached to the bottom of the intermediate case. It is electrically controlled by the EEC and supplied with HP3 air. When energized, the solenoid valve sends HP3 air pressure to the actuating ram (piston). The TIC is only active during stable cruise mode and the EEC control is based on Engine Pressure Ratio (EPR) and Mach number, or N1 and A/C altitude. The actuating ram is attached to the HP/IP turbine casing and is pneumatically operated by the HP3 air pressure from the solenoid valve. The TIC valve is operated by the actuating ram, and is spring loaded closed. The valve is fully closed when the actuating ram is retracted, and it goes to the fully open position when the actuating ram is extended.
The cooling air is directed to the IP turbine casing through an air manifold with two lines of rows drilled at equal distance around its inner surface.
A liner assembly is installed around the LP turbine case to let the cooling air from the manifold flow around it.

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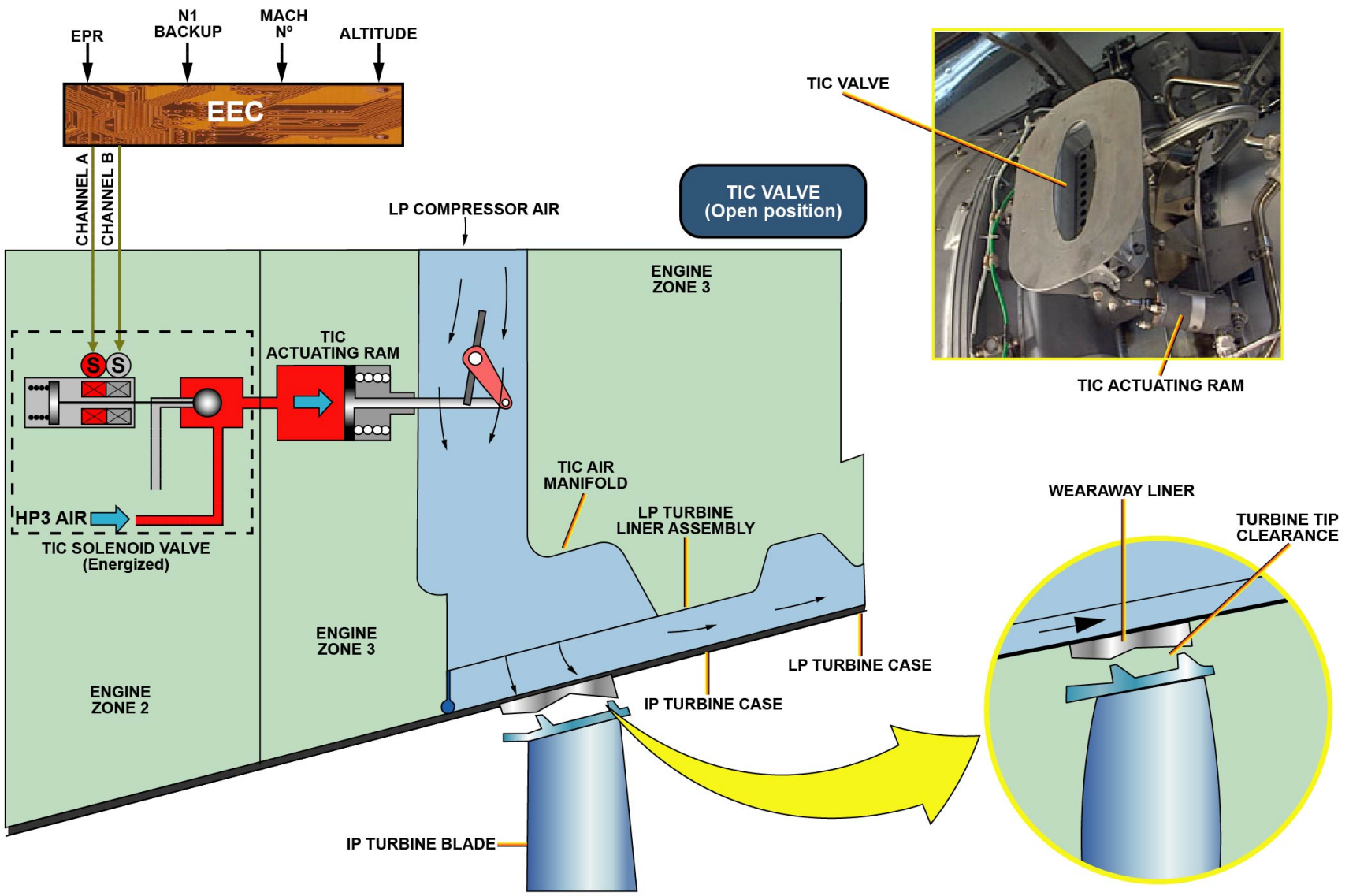

TURBINE IMPINGEMENT COOLING (TIC) D/O - DESCRIPTION & OPERATION

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THRUST CONTROL D/O (3)

GENERAL

The engine thrust is controlled by the Engine Electronic Controller (EEC).
The engine thrust can be set:
- Manually by the throttle control lever or,
- Automatically by the Auto Flight System (AFS).

The main thrust control parameter is the Engine Pressure Ratio (EPR).
The EPR is replaced by N1 (LP rotor) in reverse thrust or in backup mode.
The EPR is calculated by the EEC as a function of the total pressure at the engine inlet P20 and the total pressure at the core engine outlet P50.
It is expressed as a ratio: EPR = P50/P20.
The throttle control lever position is also used by the EEC to define the thrust limit mode and to compute the EPR rating limit.
The thrust limit mode and the EPR rating limit are used by the AFS in autothrust mode.
The thrust control parameters are displayed on the ECAM E/WD:
- EPR (actual),
- EPR (limit),
- Thrust Limit mode,
- N1.

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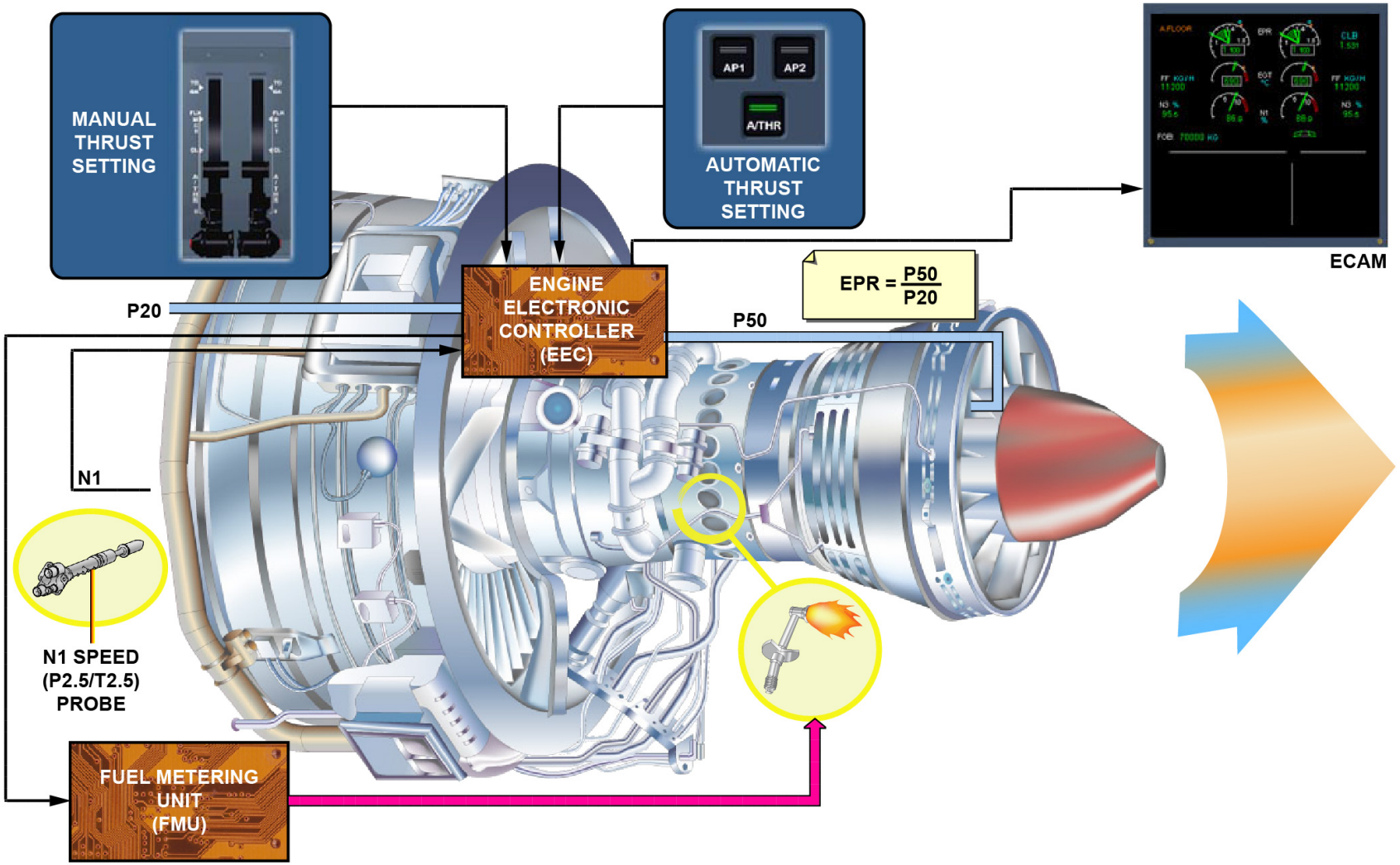

GENERAL

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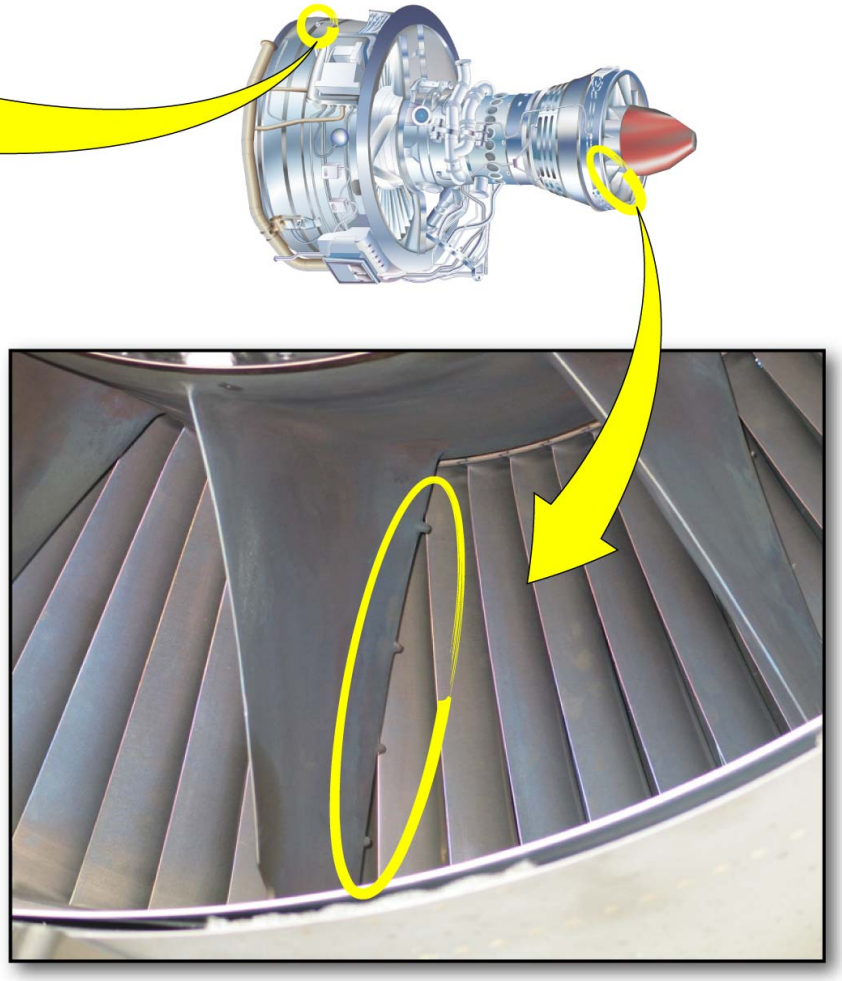
P20/T20 PROBE



P50 TAPPING POINTS

GENERAL

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THRUST CONTROL D/O (3)

GENERAL (continued)

MANUAL THRUST

The engines are in manual mode, provided the Autothrust (A/THR) function is not engaged, or is engaged and not active (throttle levers not in the A/THR operating range). In these conditions, each engine thrust is controlled by the position of its throttle control lever.
To control the thrust, the pilot moves the throttle control lever between the IDLE and TOGA (Take Off Go Around) positions. Each position within these limits is related to a predicted (or commanded) EPR shown as a blue circle on the EPR indicator.
At the end of the thrust adjustment, the actual EPR (green needle and digital indication) is aligned with the predicted/commanded EPR value.
When the throttle control lever is in a detent, the related EPR is equal to the EPR rating limit calculated by the EEC.
Between idle and max power, there are 2 detent positions:
- CL (Climb)
- FLX/MCT (Flex/Max Continuous Thrust).

If the EEC finds that the EPR is not accurate, the EEC automatically goes back to N1 MODE: the EEC uses the N1 parameter to calculate the thrust. The N1 mode can also be set manually by the operation of the N1 MODE pushbutton on the cockpit overhead panel.
In the N1 MODE, the predicted N1 related to the thrust lever position is shown by a blue circle. An amber index shows the N1 limit value of the TOGA or REV mode.
During take-off the engine thrust is manually set at FLX/MCT or above (TOGA). The maximum TOGA thrust is calculated by the EEC based on ambient conditions and is displayed on the E/WD as soon as one engine is started.
In flight, the FLX/MCT detent is used for a single engine operation. Autothrust is available in this configuration.

The pilot has the option to use less than the maximum thrust (40% thrust reduction) for takeoff in specific conditions (altitude, temperature, A/C weight, runway length, etc.). This is known as a FLEX Takeoff. The pilot must consult the Flight Manual (FM) and enter a FLEX TEMP (fictitious temperature between -128 °C and +128 °C) into the Flight Management System (FMS) through the MCDU. The throttle control lever is in the FLX/MCT detent position and a new lower thrust limit will be displayed on the E/WD.

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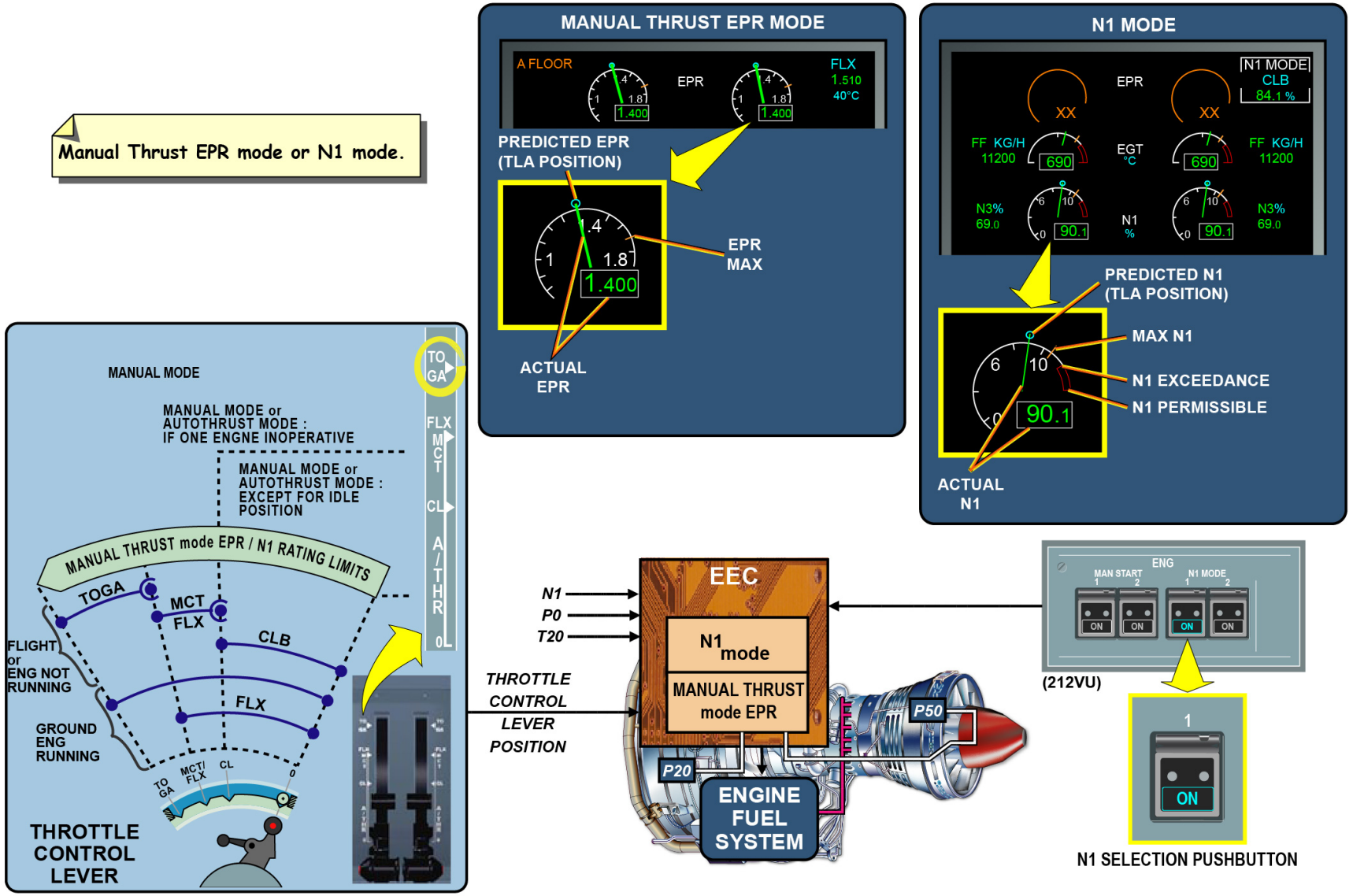
Manual Thrust EPR mode or N1 mode.



GENERAL - MANUAL THRUST

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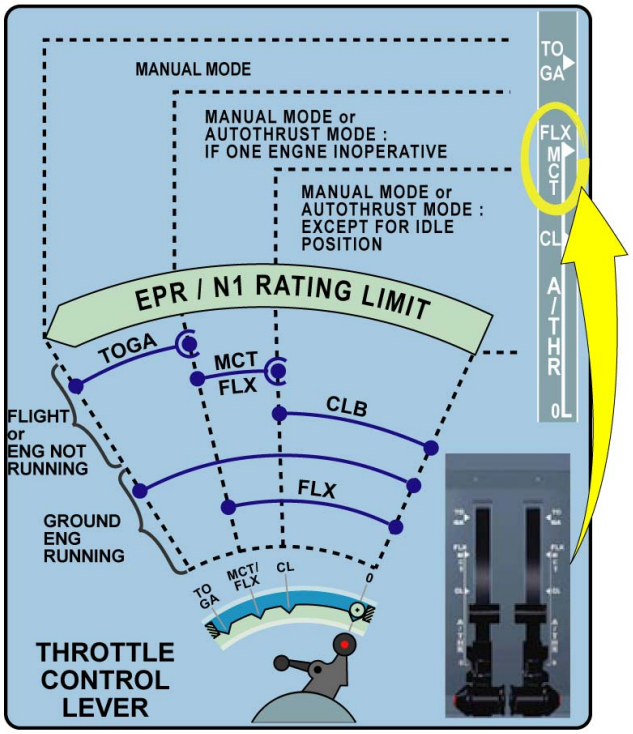

GENERAL - MANUAL THRUST

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THRUST CONTROL D/O (3)

AUTOMATIC THRUST

A/THR is a function of the FMS. The FMS includes the Flight Management Guidance and Envelope Computers (FMGECs), the Flight Control Unit (FCU) and, the MCDUs.
The FCU is installed on the glareshield panel and the MCDUs are installed on the center pedestal. They are the interfaces between the flight crew and the FMGECs.
The FCU is equipped with an A/THR pushbutton to engage or to disengage the autothrust. When ENGAGED, the A/THR may be ACTIVE or NOT ACTIVE. The A/THR is ACTIVE when the thrust control levers are in the A/THR range (above IDLE to FLX/MCT detent), The A/THR is NOT ACTIVE when the thrust control levers are not in the A/THR range (at IDLE stop or above the FLX/MCT detent). The A/THR may also be disengaged using the Instinctive Disconnect Switch on the throttle control levers.
The MCDU is used to enter the flight plan and FLEX TAKEOFF Temperature. If equipped with the optional capability, derated take off and derated climb are also entered through the MCDU.
Alpha Floor (A.FLOOR) protection is used to prevent an aircraft stall. It is automatically activated by the FMGEC if the aircraft reaches an exccessive angle-of-attack. When activated, the maximum engine thrust (TOGA) is automatically commanded regardless of the throttle control lever position, with the autothrust engaged or not.

AUTOMATIC THRUST ENGAGEMENT

The A/THR pushbutton lets engage, or disconnect the A/THR. It comes on green when the A/THR is engaged.
The A/THR is active when it is engaged and the thrust levers are set in the A/THR operating range (between IDLE and CL).
Note that during take-off, the A/THR function is engaged but not active.

In case of reversion to N1 mode on one engine, the A/THR is deactivated.
The A/THR system can operate with or without the AP.
If the A/THR is working with the AP, the FMGEC commands the thrust according to the AP logic. The thrust is limited by the position of the throttle lever. (For example, when the throttle levers are set to CL, A/THR can command a thrust between IDLE and CL).
If the A/THR is working without the AP, the A/THR always controls the aircraft speed. The thrust is always limited by the position of the throttle lever.
In case of A/THR failure, the A.FLOOR protection is lost.

A/THR MODE DISCONNECTION

Standard disconnection, by pushing one of the instinctive disconnect Pushbuttons (P/Bs) on the throttle levers, the A/THR mode is disconnected and the thrust is set in manual mode, according to the actual throttle control lever position. If instinctive disconnect P/B is pushed and held for more than 15 seconds, all A/THR functions including A.FLOOR protection are lost for the flight in progress.
Setting all throttle levers to IDLE detent results in A/THR disconnection.
Non-standard disconnection results in activation of the thrust lock function when:
- the A/THR pushbutton is released out while A/THR is engaged or active, or
- the system looses one of the engagement conditions, or
- the throttle lever is set at CL or at MCT when one engine is inoperative.

The Thrust lock function is locked or frozen at the level set prior to the non standard disconnection. Moving the throttle levers out of CL (or MCT with one engine inoperative) cancels the thrust lock function, and the thrust reverts to manual control.

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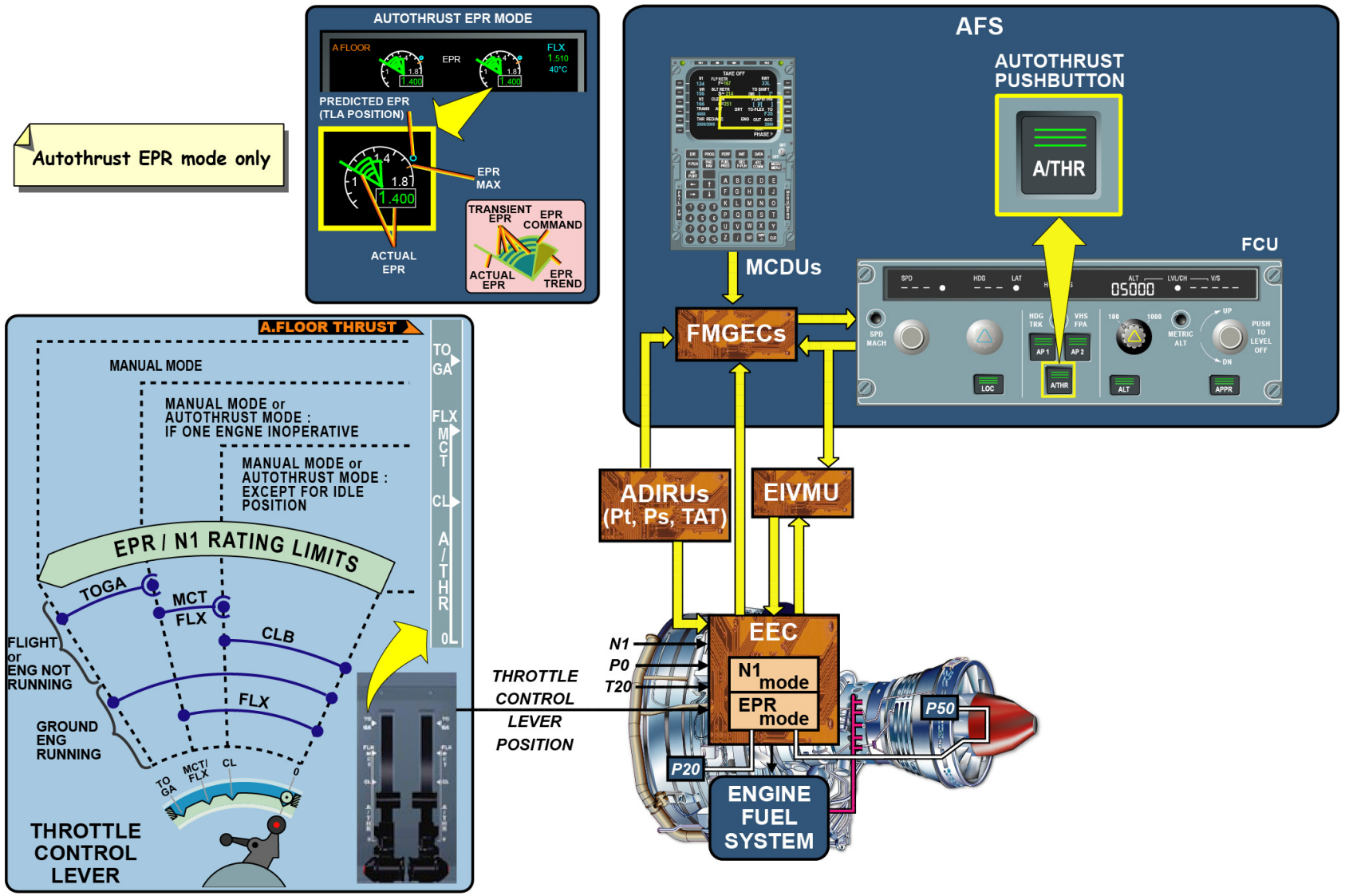

AUTOMATIC THRUST - AUTOMATIC THRUST ENGAGEMENT & A/THR MODE DISCONNECTION

THRUST CONTROL D/O (3)

EPR MODE OPERATION

EPR mode is the normal thrust control mode. The EEC computes the EPR command as a function of:
- TRA,
- altitude or static pressure (Ps or P0),
- total air pressure (Pt or P20),
- P50
- Total Air Temperature (TAT or T20),
- mach number,
- bleed demand.

The EPR rating limit is computed by the EEC, depending on the TRA, and is displayed in green on the upper ECAM. The EPR limit value displayed is the highest EPR limit value of the two engines.

N1 MODE OPERATION

If the EEC is unable to compute EPR, the engine thrust control automatically reverts to N1 mode. The N1 mode can also be commanded manually by selecting the ENG N1 MODE P/B ON. Upon automatic reversion to N1 mode, a thrust equivalent to that achieved in EPR mode is set and locked by the EEC until the operator changes the throttle control lever position. An ECAM message will be generated, requesting that the operator select BOTH engines to N1 mode keep the throttle control levers matched.

There are two N1 modes for thrust control. Depending on the failure conditions leading to EPR mode loss, the EEC will revert to either rated N1 or unrated N1 mode.

RATED N1 MODE

An automatic reversion to rated N1 mode occurs, when:
- engine P20 and / or P50 are not available,
- engine P20 is lower than Air Data/Inertial Reference Units (ADIRUs) Pt.

The EEC computes an EPR command, depending on the TLA, then converts it to an N1 command as a function of Mach number.

The displayed N1 rating limit is only computed in the N1 rated mode, according to the TRA. The Max thrust and throttle control lever position indications shift from the EPR indicator to the N1 indicator.

UNRATED N1 MODE

An automatic reversion to unrated N1 mode occurs, when:
- engine P20 and ADIRUs Pt are not available, or
- engine T20 and ADIRUs TAT are not available, or
- engine P0 and ADIRUs Ps are not available.

N1 command is defined as a function of the TLA and altitude. N1 is limited by the EEC to either the smaller of N1 max or N1 redline, depending on T20 availability. The N1 rating limit, predicted N1 (N1 TLA) and N1 MAX ECAM indications are lost. Basically, there is no engine limit protection in this mode.

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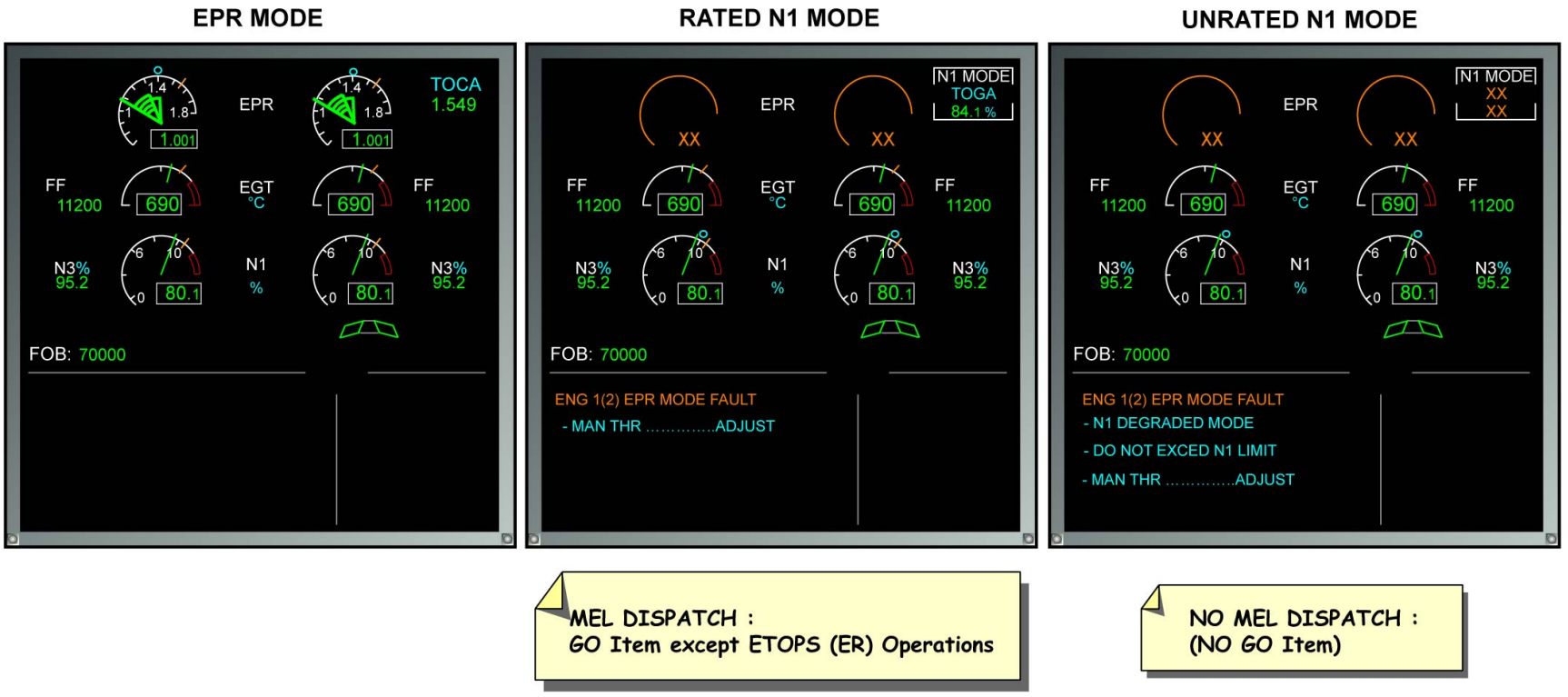

EPR MODE OPERATION & N1 MODE OPERATION

THRUST CONTROL D/O (3)

THROTTLE CONTROL LEVER ASSEMBLY

Each throttle control lever mechanical assembly includes the throttle control lever connected to the artificial feel unit and a Throttle Control Unit (TCU) by adjustable rods. The throttle control lever incorporates the thrust reverse control lever and the Instinctive Disconnect P/B Switch for the A/THR.

THROTTLE CONTROL LEVERS

The throttle control lever position input to the TCU is the Throttle Lever Angle (TLA). The throttle control levers range of movement is from the IDLE stop (0° TLA) to the TOGA stop (55° TLA). There are two detents: CL and FLX/MCT.

THRUST REVERSER CONTROL LEVERS

The thrust reverser control lever position input to the TCU is the Reverser Lever Angle (RLA). The thrust reverser control levers range of movement is from the IDLE stop (0° RLA) to the MAX REVERSE stop (96° RLA). At 51.5° RLA there is a REVERSE IDLE detent point.

THROTTLE CONTROL ARTIFICIAL FEEL UNIT

The throttle control artificial feel unit is a friction system which supplies an artificial load feedback to the throttle control levers and the reverser control levers. The load may be adjusted on the unit using a specific load measuring tool.

THROTTLE CONTROL UNIT

The primary component of the TCU is the dual resolver. The resolver is a FADEC component, which receives its excitation current from the EEC and transmits the throttle control lever position signal back to the EEC. This signal is the throttle resolver angle (TRA).
The TRA signal is used to set the engine thrust in manual and reverse thrust. In automatic thrust, the TRA is used by the EEC to set the thrust limit. In other words, during normal autothrust operation, the engine thrust will likely be less than the thrust limit based on the throttle control lever position which is indicated by the cyan (blue) circle on the indicator.
The TCU also includes three potentiometers and a microswitch. The potentiometers are not part of the FADEC system but send throttle control lever position to the Flight Control Primary Computers (FCPCs) for control of the thrust reverser independent locking system tertiary locks. The microswitch sends a "thrust reverse selected" signal to the EIVMU for thrust reverser deployment control.

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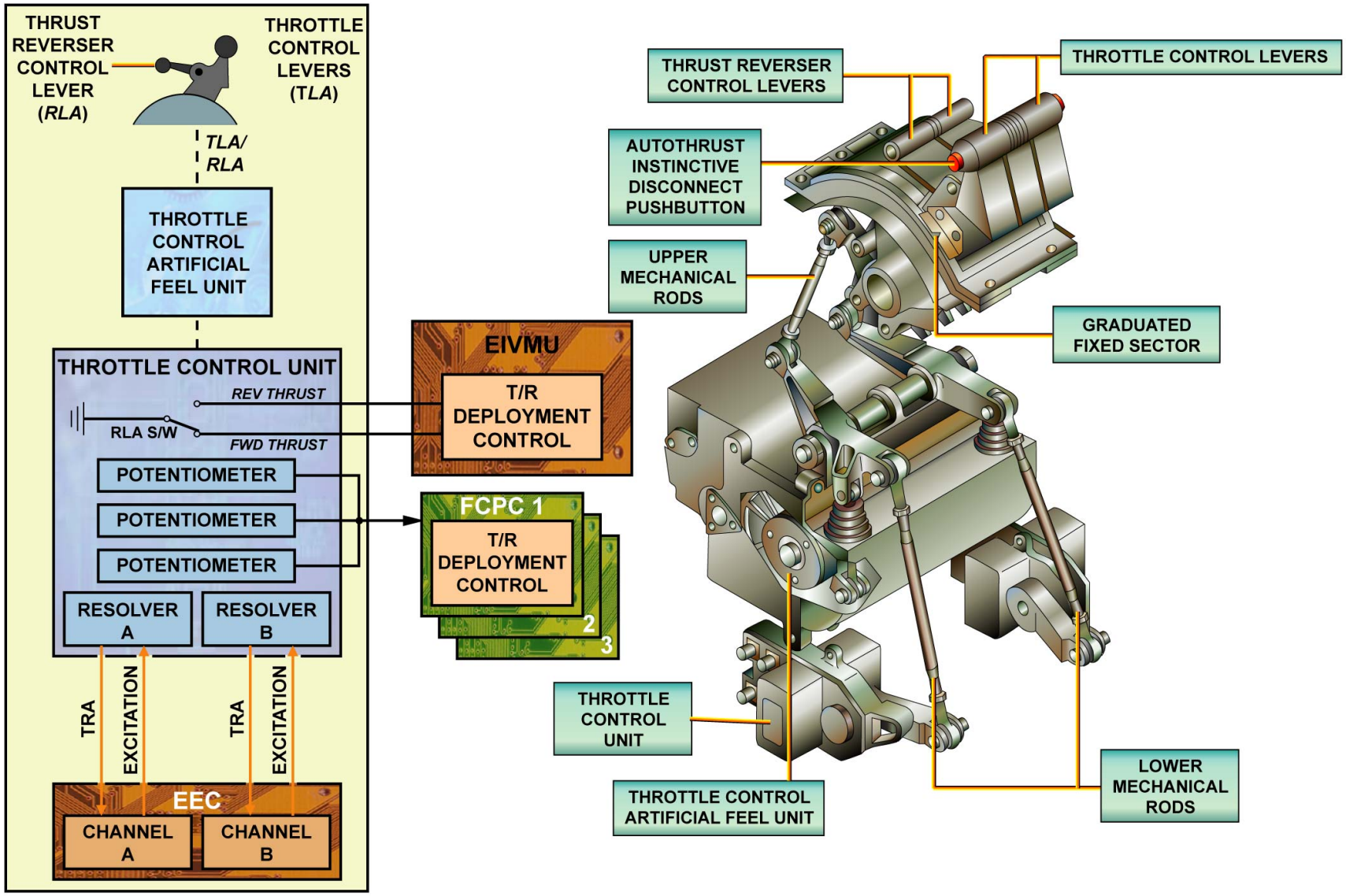

THROTTLE CONTROL LEVER ASSEMBLY - THROTTLE CONTROL LEVERS ... THROTTLE CONTROL UNIT

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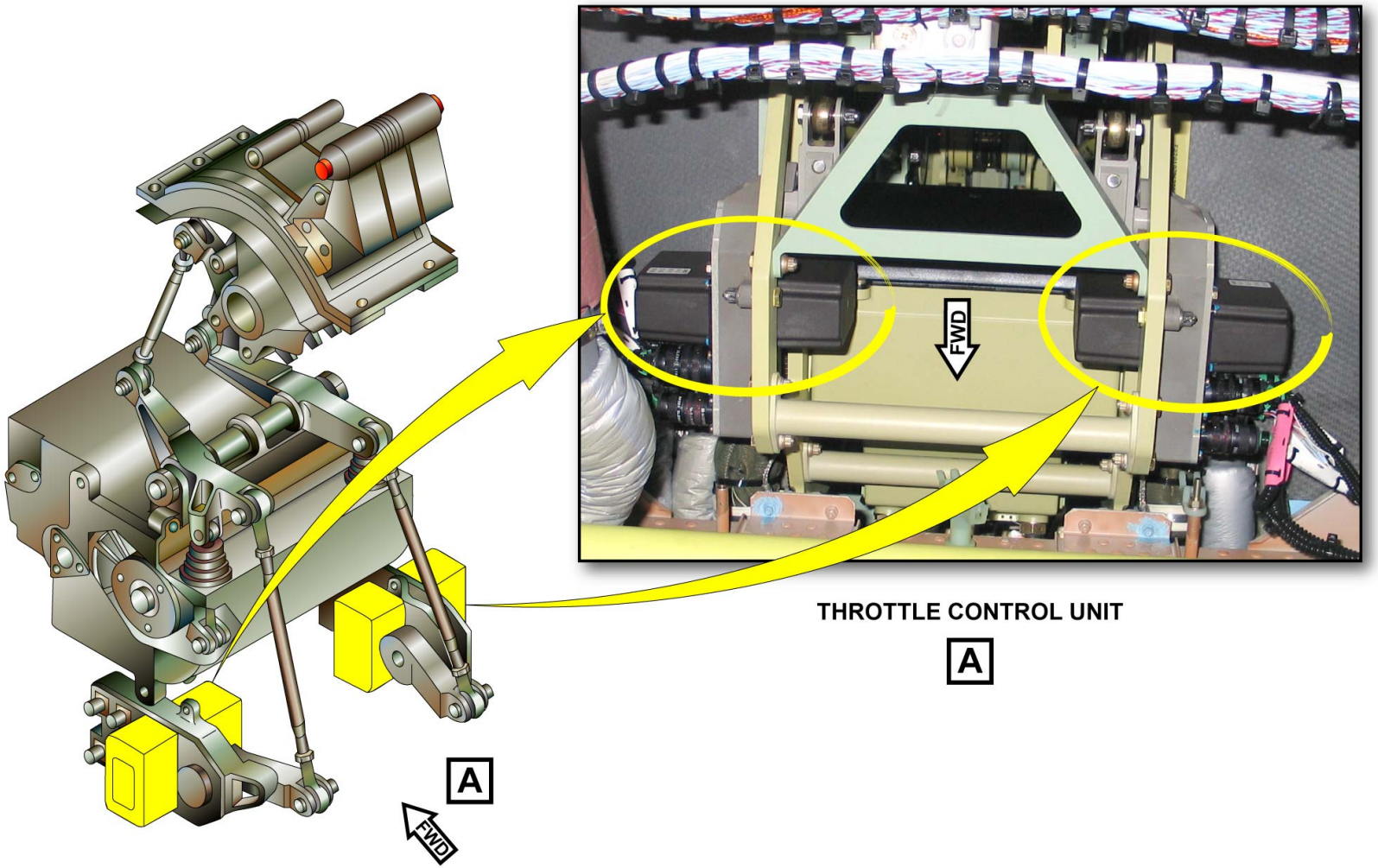

THROTTLE CONTROL LEVER ASSEMBLY - THROTTLE CONTROL LEVERS ... THROTTLE CONTROL UNIT

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ENGINE MASTER CONTROL D/O (3)

GENERAL

The ENGine MASTER lever located on the center pedestal, interfaces with the fuel system and the FADEC system.
On the fuel system, the ENGine MASTER lever acts on the LP valve and the Pressure Raising and Shut-Off Valve (PRSOV). Note that the ENGine FIRE pushbutton also acts on the LP fuel valve.
On the FADEC system, the ENGine MASTER lever is used for selection of the starting mode and for reset of the Engine Electronic Controller (EEC) memory.

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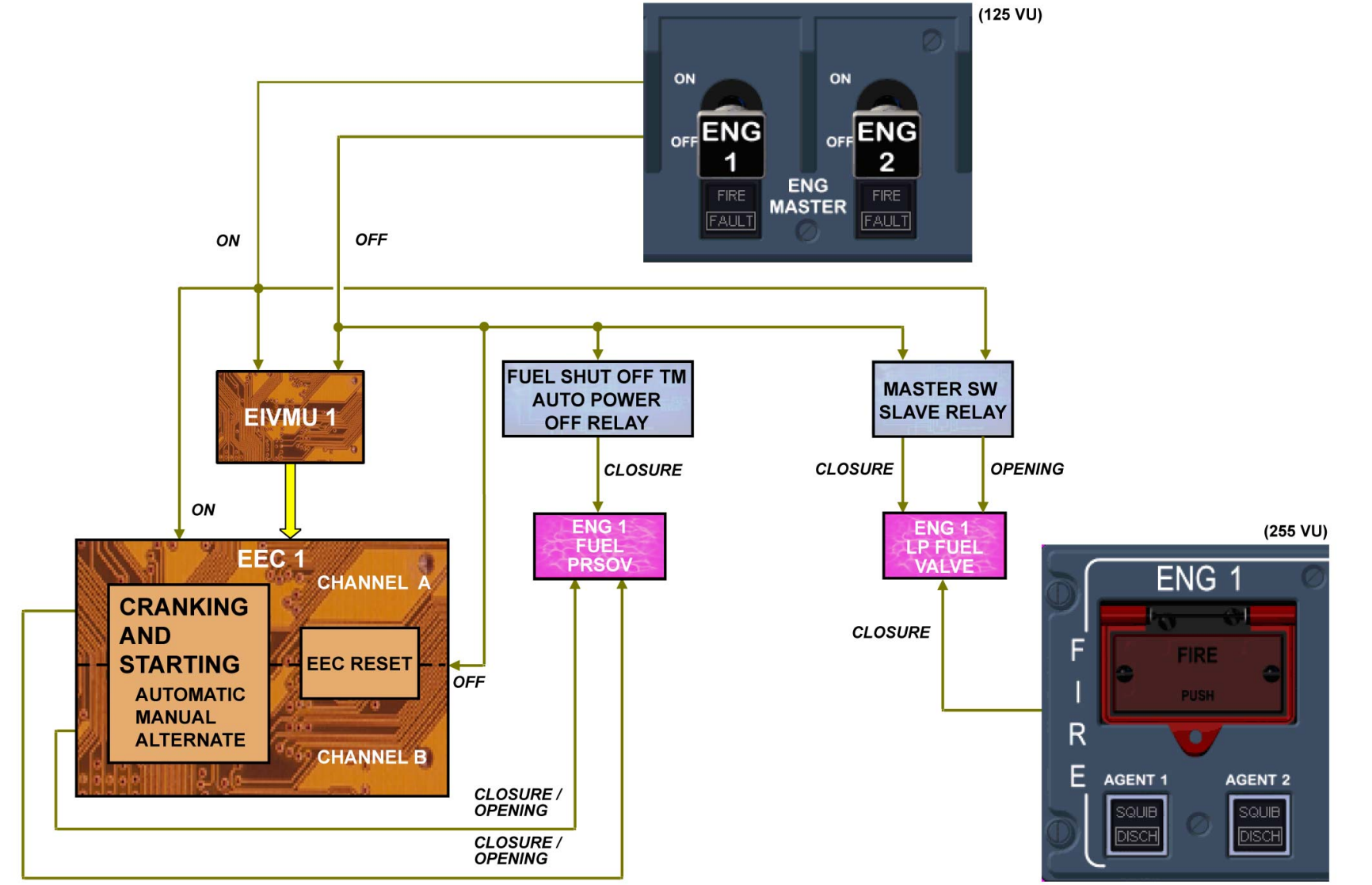
(125 VU)
ON
OFF
ENG 1
FIRE
FAULT
ENG MASTER
ENG 2
FIRE
FAULT
ON
OFF
EIVMU 1
FUEL SHUT OFF TM AUTO POWER OFF RELAY
MASTER SW SLAVE RELAY
CLOSURE
CLOSURE
OPENING
ON
EEC 1
CHANNEL A
CRANKING AND STARTING
AUTOMATIC
MANUAL
ALTERNATE
EEC RESET
OFF
CHANNEL B
ENG 1 FUEL PRSOV
ENG 1 LP FUEL VALVE
CLOSURE
(255 VU)
ENG 1
FIRE
PUSH
F
I
R
E
AGENT 1
SQUIB
DISCH
AGENT 2
SQUIB
DISCH
CLOSURE / OPENING
CLOSURE / OPENING

GENERAL

ENGINE MASTER CONTROL D/O (3)

FUEL LP VALVE AND PRSOV CONTROL

The ENGine MASTER lever simultaneously controls the LP fuel line and the High Pressure (HP) fuel line opening and closure.

LP VALVE AND SLAVE MASTER SWITCH RELAY

The ENGine MASTER lever controls the low pressure fuel supply from the aircraft wing through the engine master switch slave relay.
When the ENGine MASTER lever is moved to the "OFF" position, the engine master switch slave relay is energized. This supplies 28 VDC power to both LP valve actuator motors and causes the LP valve to close.
The MASTER switch slave relay takes its 28 VDC power supply from the PRSOV C/B.
One actuator motor of the LP valve is electrically supplied from the DC HOT BUS.
Pulling out the PRSOV C/B or switching off the aircraft power supply, leads to the automatic opening of the LP valve.
The LP valve fail-safe opening logic is mainly used for the engine dry motoring procedure. Pulling out the PRSOV C/B, while the ENGine MASTER lever is kept "OFF", makes the fuel feeding to the engine fuel pumps for their lubrication.
Selection of the ENGine FIRE pushbutton leads to LP valve closure, regardless of the ENGine MASTER lever position.

PRSOV AND AUTO POWER OFF RELAY

The ENGine MASTER lever is directly hardwired to the fuel shut off torque motor. It provides an independent authority to shut down the engine by cutting off the fuel supply, regardless of the EEC command.
When the ENGine MASTER switch is set to "OFF", an aircraft 28 VDC closes the auto power off time delay relay and supplies the fuel shut off torque motor, resulting in the PRSOV closure.
Two minutes later, the auto power off relay cuts off the power supply to the fuel shut off torque motor. The PRSOV is maintained in the closed position by spring load.
The PRSOV position indication signals are sent to both EEC channels by two microswitches.

ENGINE MASTER PANEL FAULT LIGHT

The amber "FAULT" light located on the ENGine MASTER panel comes on in case of:
- an aborted starting procedure during an autostart sequence,
- a PRSOV position disagree.

In case both PRSOV microswitches disagree with the MASTER lever position, the EEC sends a fault signal to the Engine Interface and Vibration Monitoring Unit (EIVMU) for "FAULT" light and corresponding ECAM message activation.

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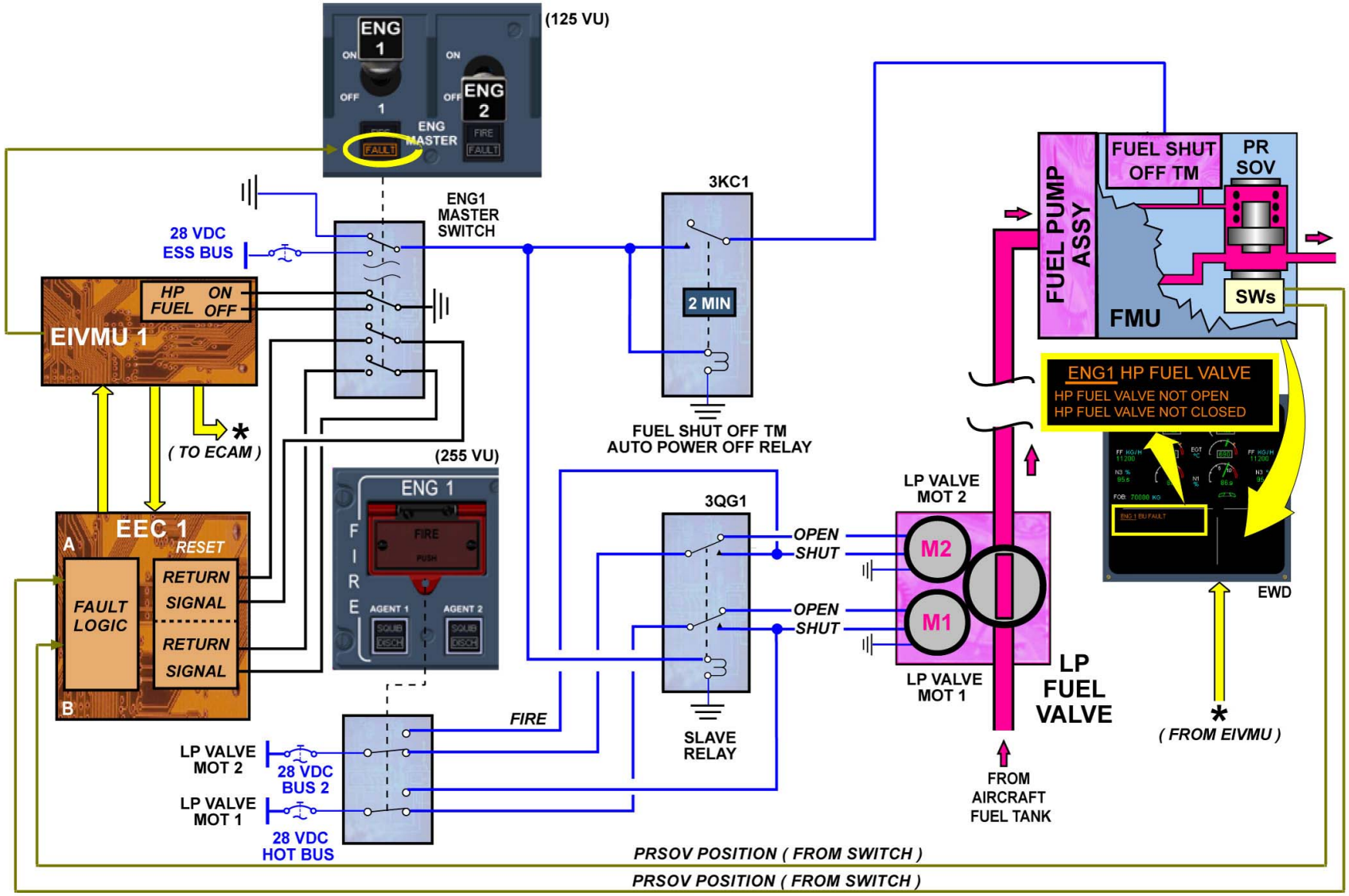

FUEL LP VALVE AND PRSOV CONTROL - LP VALVE AND SLAVE MASTER SWITCH RELAY ... ENGINE MASTER PANEL FAULT LIGHT

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ENGINE MASTER CONTROL D/O (3)

MASTER LEVER STARTING AND RESET FUNCTION

The ENGine MASTER switch interfaces with the starting sequence and memory reset function of the EEC.

STARTING MODE OPERATION

During engine start, the ENGine MASTER switch command signal is sent to the EIVMU, which then transmits the information to the EEC in digital format.
In case of EIVMU failure or loss of the EIVMU output data, the EEC uses its reset hardwired discrete signals from the ENGine MASTER switch as command signal.

RESET FUNCTION

The ENGine MASTER switch is directly hardwired to the EEC to satisfy the reset function. Moving the ENGine MASTER lever from "ON" to "OFF" position closes both channel reset discrete contacts, thus resetting both EEC channels; all data stored in the EEC RAM memory will be cleared.

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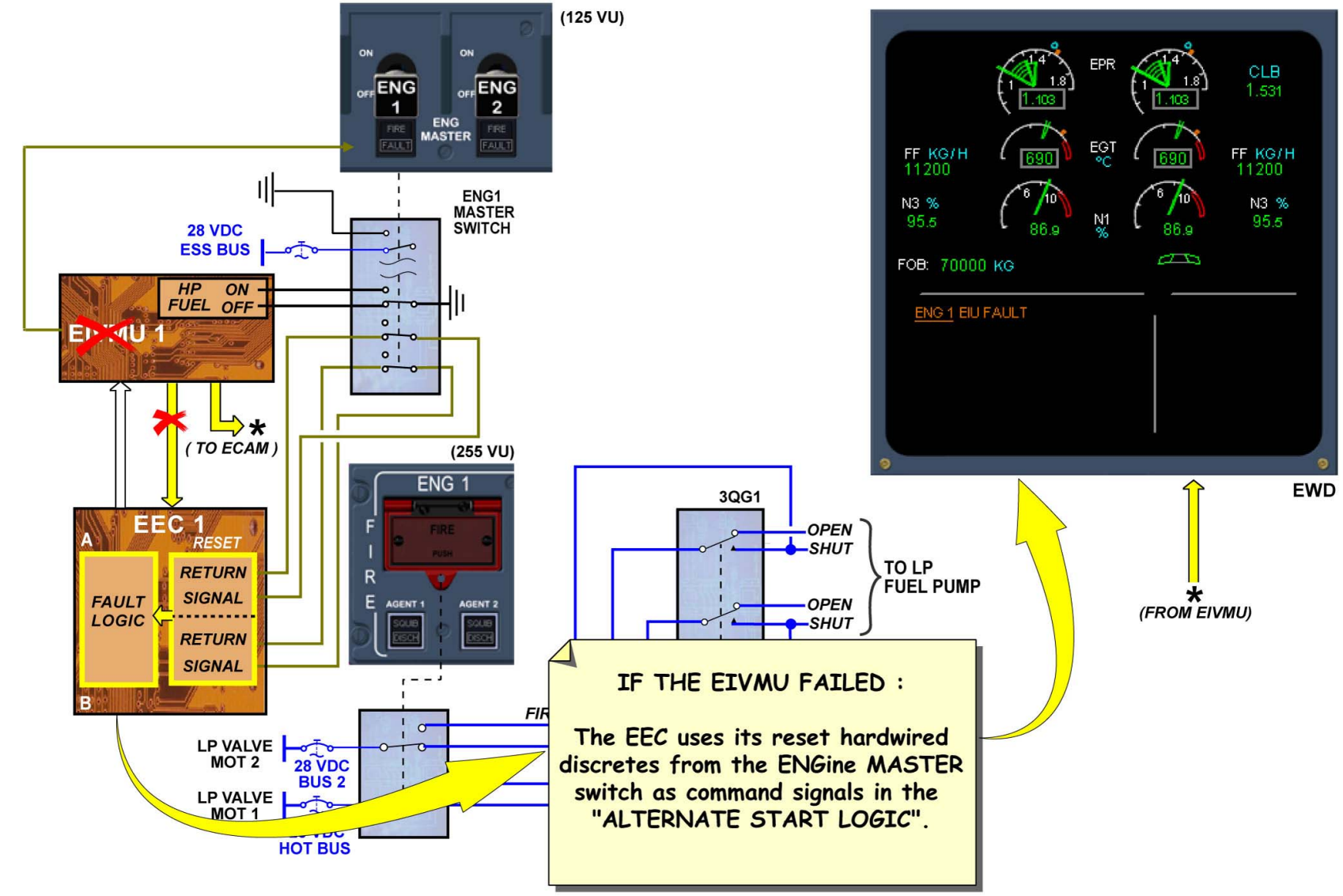

MASTER LEVER STARTING AND RESET FUNCTION - STARTING MODE OPERATION & RESET FUNCTION

VIBRATION MONITORING SYSTEM D/O (3)

GENERAL

The vibration monitoring system supplies continuous indications of the state of balance of the N1, N2 and N3 engine rotors.
This indication is available on the SD ENGINE page during all engine operating conditions.
The vibration monitoring system also helps the operators to do the maintenance operations such as fan trim balance and to monitor the engine vibration trend.

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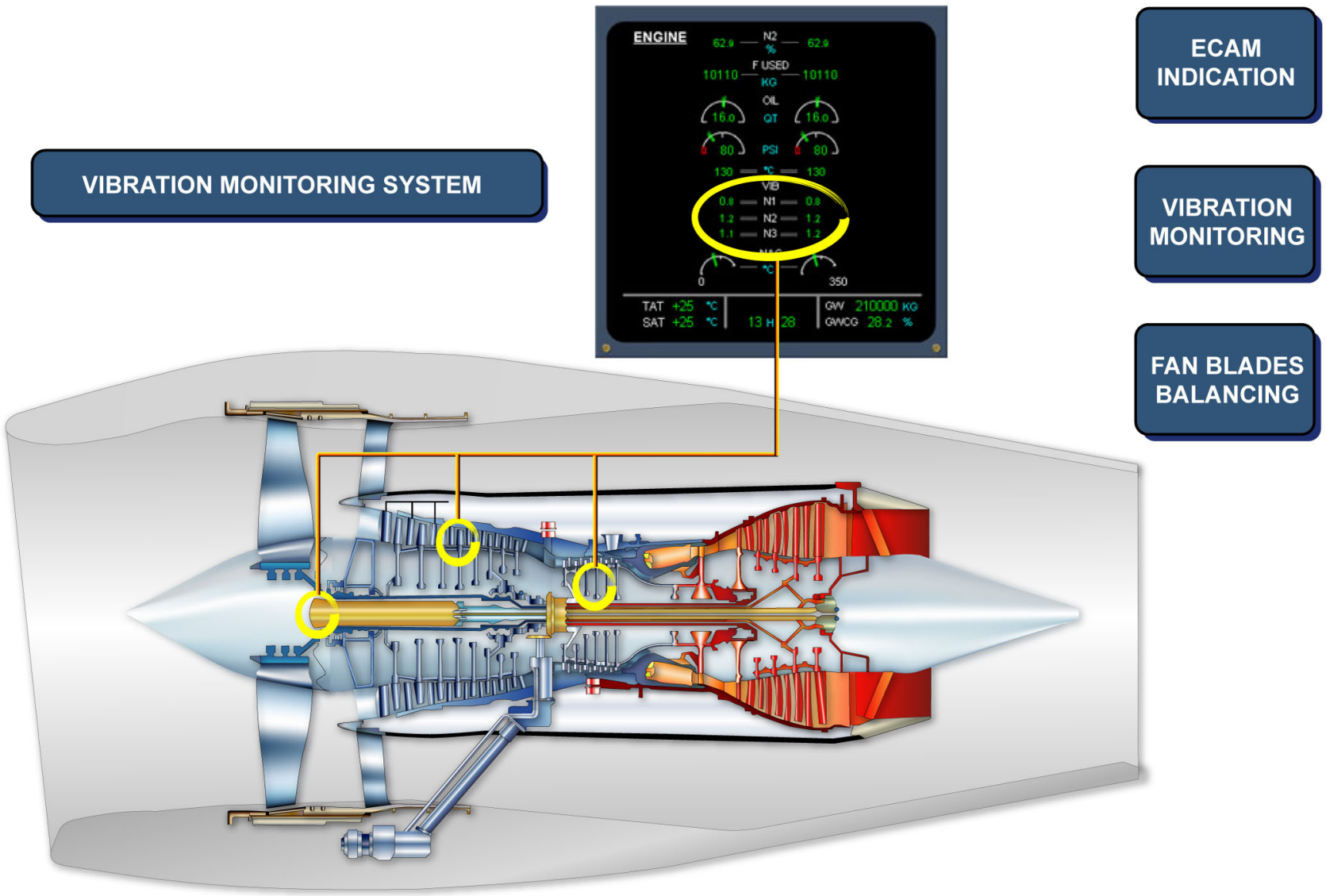
VIBRATION MONITORING SYSTEM
ENGINE
N2
%
F USED
KG
OIL
QT
PSI
VIB
N1
N2
N3
TAT +25 °C
SAT +25 °C
GW 210000 KG
GWCG 28.2 %
ECAM INDICATION
VIBRATION MONITORING
FAN BLADES BALANCING

GENERAL

VIBRATION MONITORING SYSTEM D/O (3)

VIBRATION MONITORING SYSTEM DESCRIPTION

The vibration monitoring system uses the N1, N2 and N3 speed indications processed by the Engine Electronic Controller (EEC) using signals from the engine N1, and N2 speed probes, and from the dedicated alternator (for N3 speed).
The vibration monitoring system comprises:
- the N1 trim balance probe,
- the dual vibration transducer, which is a dual output accelerometer,
- the vibration junction box,
- the Remote Charge Converter (RCC),
- the Engine Interface and Vibration Monitoring Unit (EIVMU).

ENGINE SHAFT SPEED AND TRIM BALANCE PROBE

N1 and N2 shaft speeds are measured using probes that interact with phonic wheels, which are installed in the front bearing housing.
The output from the N1 and N2 speed probes is sent to the EEC via the Overspeed Protection Unit (OPU). One of the phase windings in each three-phase circuit of the dedicated alternator supplies the EEC, via the Power Control Unit (PCU), with the N3 shaft speed.
The trim balance probe is installed in the engine front bearing housing. It sends a once-per-revolution signal for the LP compressor shaft to the EIVMU. The trim balance probe is identical to the N1 speed probes.

VIBRATION TRANSDUCER AND VIBRATION JUNCTION BOX

The vibration transducer is a dual output accelerometer installed on the RH side of the engine intermediate case. It contains two piezo-electric crystal stack elements, with a mechanical load of an electrically insulated seismic mass. Each element is connected to an electrical lead. Both leads are connected to the vibration junction box.

The vibration junction box is attached to the right engine intermediate case and is divided into two parts. Each part contains the terminals where a transducer lead and cables which go to the RCC, are connected.

REMOTE CHARGE CONVERTER (RCC)

The RCC is an electronic unit installed on the LH side of the fan case. It receives the signals from the vibration transducer via the vibration junction box.
These signals are filtered, [amplified and [modulated into voltage signals, [to be sent to the EIVMU.

ENGINE INTERFACE AND VIBRATION MONITORING UNIT (EIVMU)

The EIVMU is installed in the aircraft avionics compartment. The EIVMU uses these data for the N1, N2, and N3 rotor vibration level determination and broadband calculation as Inch Per Second (IPS) data.
The N1, N2, and N3 rotor vibration levels are displayed on the ENGINE system page and are also available for maintenance purposes through the MCDU via the Central Maintenance Computer (CMC).

VIBRATION MONITORING SYSTEM OPERATION

To indicate engine vibration levels in the cockpit or to let operators do a fan trim balance, the EIVMU uses information from the RCC, the EEC, and from the trim balance probe.

REMOTE CHARGE CONVERTER (RCC)

The engine vibrations cause the seismic mass in the transducer to apply pressure on the piezo-electric crystal stack elements.
This causes the elements to generate electrical signals proportional to the engine vibration. The signals are then sent to the RCC which amplifies them to give output signals to the EIVMU.

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ENGINE ELECTRONIC CONTROLLER (EEC)

The engine speed signals N1, N2 and N3 are sent to the EIVMU through an ARINC data bus connection, and are used for vibration retrieval and display on the MCDU through the EIVMU menu.

TRIM BALANCE PROBE

Once-per-revolution analog signal is sent by the trim balance probe to the EIVMU. It is used for determination of the N1 unbalance phase angle. This phase angle is accessible through the EIVMU menu and is used, with the vibration amplitude, for the fan trim balance procedure.

VIBRATION INDICATING AND MAINTENANCE DATA

The EIVMU maintains the interface between the engine systems and the aircraft, and sends ARINC data to the cockpit.

VIBRATION INDICATING

The vibration indication is displayed on the ECAM ENGINE and CRUISE pages. The vibration data from the EIVMU in IPS are converted in "cockpit UNITS" in a range from 0 to 10.
An ECAM advisory informs the flight crew when N1, N2 or N3 vibration level exceeds a specific value. In such a case, the vibration over limit value pulses in green.

VIBRATION MAINTENANCE DATA

The Aircraft Maintenance Manual (AMM) 71-00-00 chapter (adjustment / test) contains the information required to do the LP compressor trim balance test (test number 16) with the engine on wing, and the engine vibration survey test (test number 11).
The LP compressor trim balance test, is done through the MCDU menus to identify where the trim balance bolts have to be installed on the LP compressor make-up piece to recover nominal balance.
The engine vibration survey test (test number 11) is done to schedule the engine module replacement as a preventive maintenance operation.

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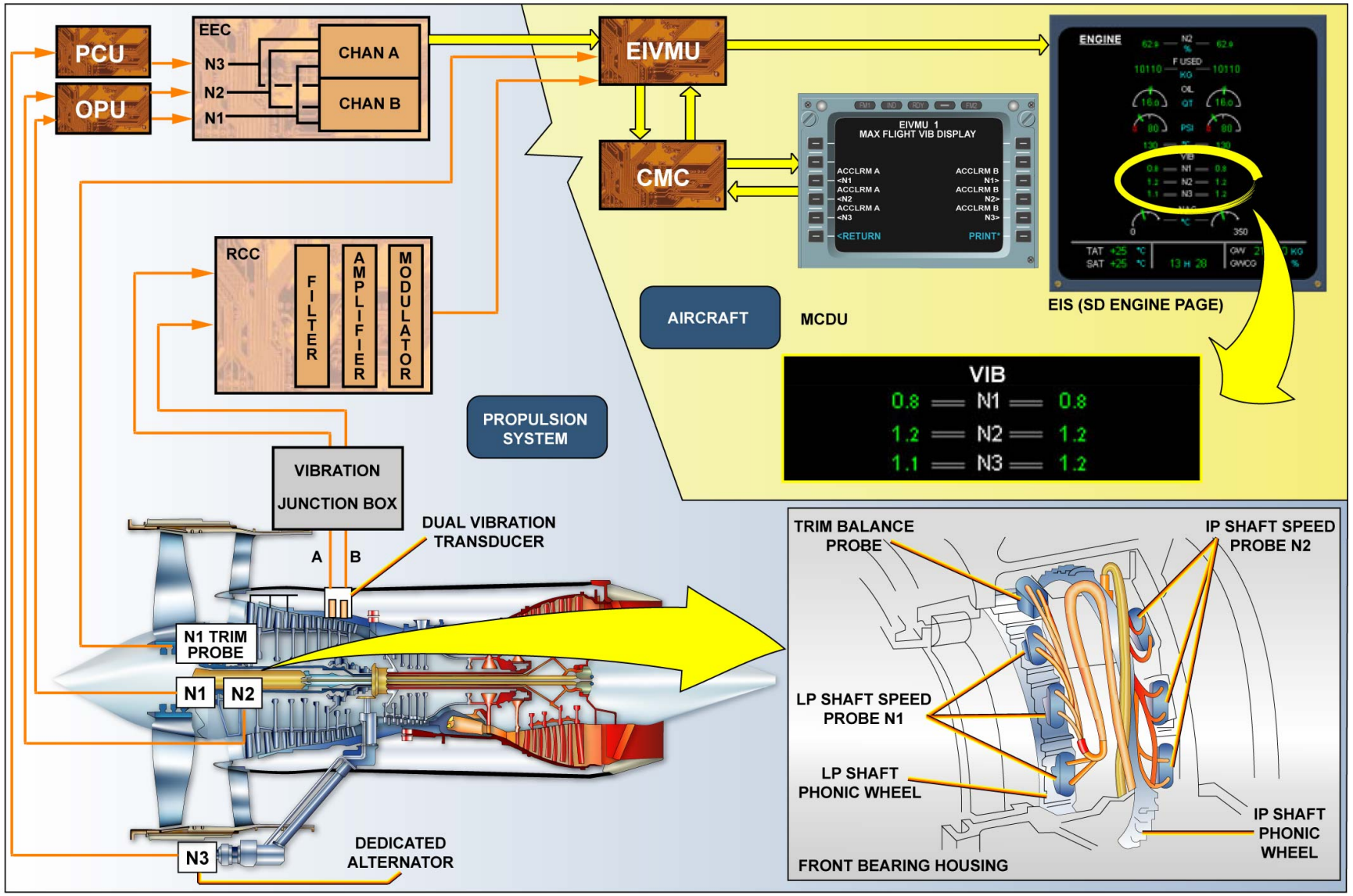
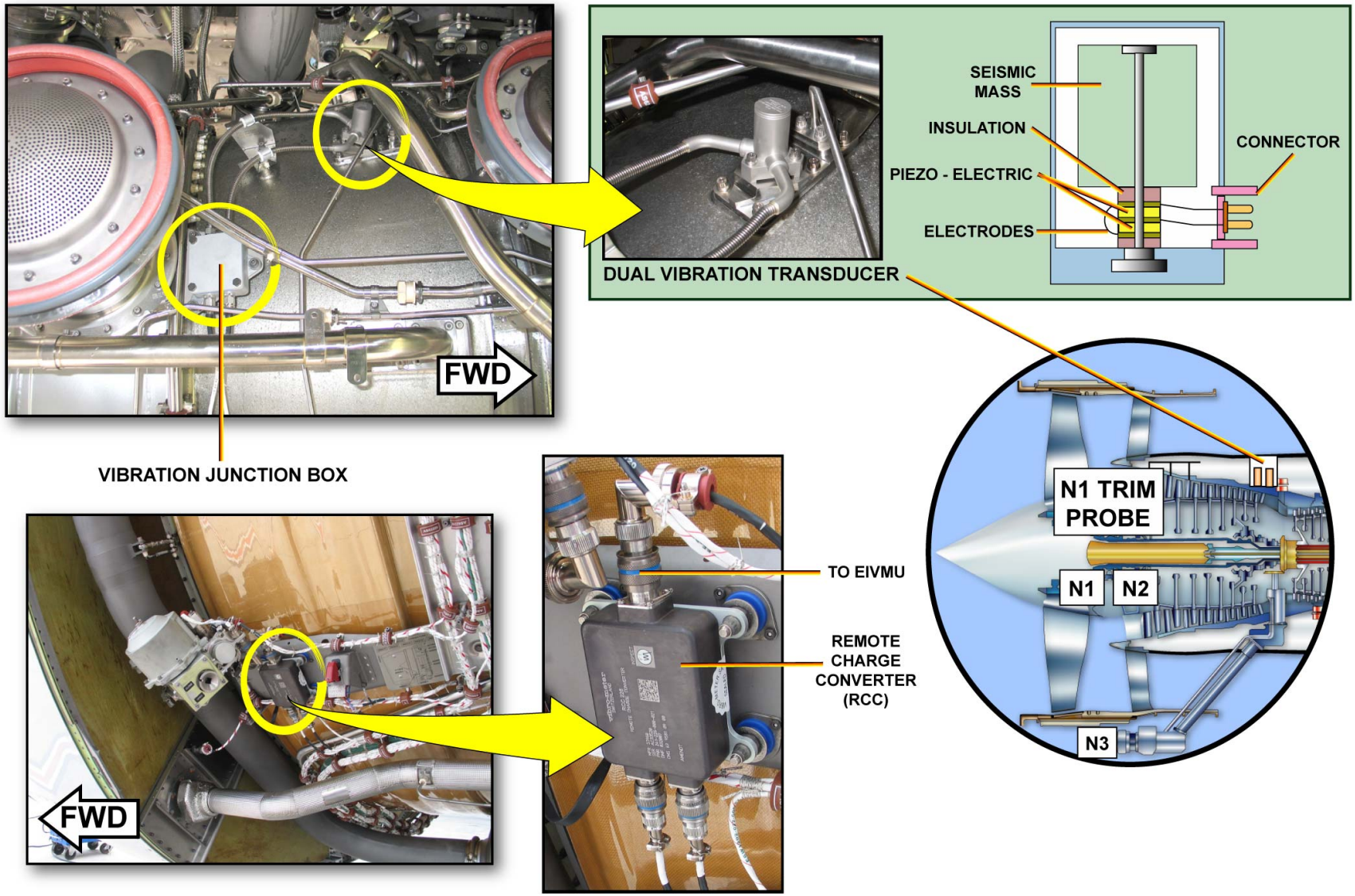


VIBRATION MONITORING SYSTEM DESCRIPTION ... VIBRATION INDICATING AND MAINTENANCE DATA



VIBRATION MONITORING SYSTEM DESCRIPTION ... VIBRATION INDICATING AND MAINTENANCE DATA

THRUST REVERSER SYSTEM D/O (3)

GENERAL

The thrust reverser system helps the wheel brakes by supplying additional deceleration forces to the aircraft.
The thrust reversers are used only on the ground to reduce aircraft roll distance for landing or in case of aborted take-off. The thrust reversers are incorporated into the left and right C-ducts. Each C-duct has 2 pivoting doors, each one operated by a hydraulic actuator.
When the pivoting doors are deployed, they stop the fan airflow to the Common Nozzle Assembly (CNA) and redirect it forward.
Thrust reverse is selected from the throttle control levers and is controlled and monitored by the Engine Electronic Controller (EEC). The pivoting door actuators are operated by the Isolation Control Unit (ICU) and the Direction Control Unit (DCU). The ICU and DCU of each engine are supplied by the engine-driven pump of that engine.

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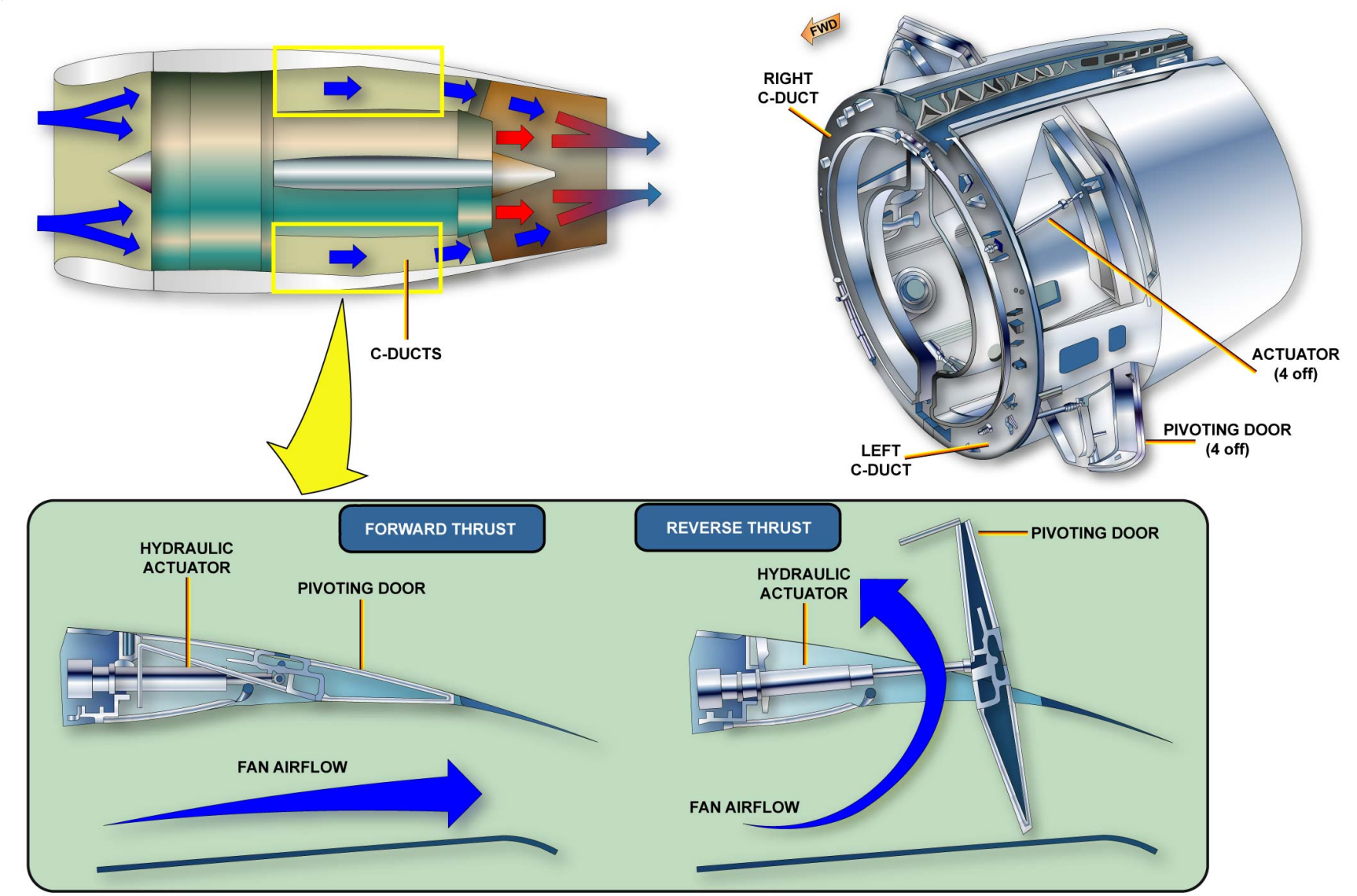
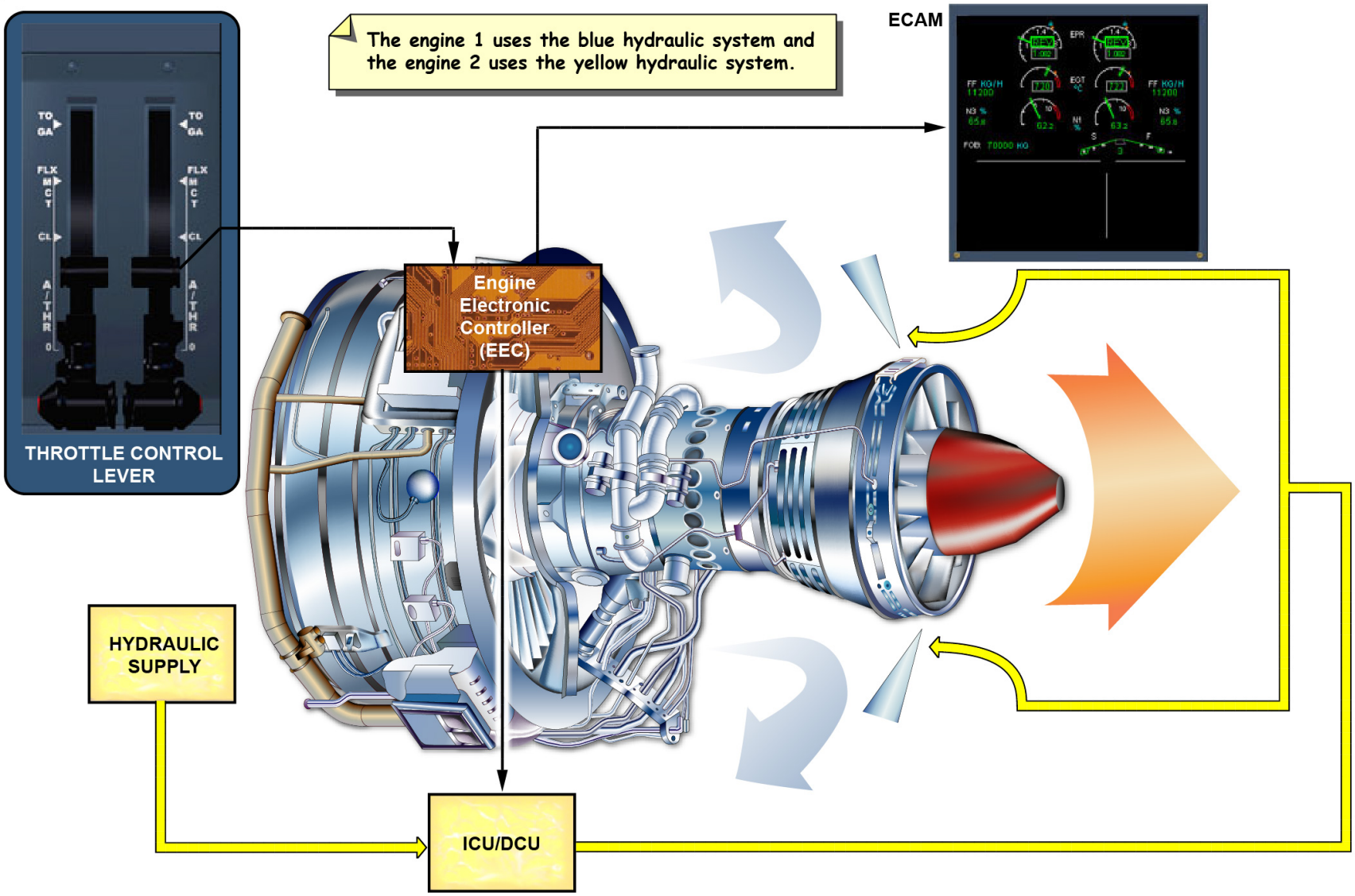

C-DUCTS
FWD
RIGHT
C-DUCT
ACTUATOR
(4 off)
PIVOTING DOOR
(4 off)
LEFT
C-DUCT
FORWARD THRUST
HYDRAULIC
ACTUATOR
PIVOTING DOOR
FAN AIRFLOW
REVERSE THRUST
PIVOTING DOOR
HYDRAULIC
ACTUATOR
FAN AIRFLOW

GENERAL


The engine 1 uses the blue hydraulic system and the engine 2 uses the yellow hydraulic system.
ECAM
THROTTLE CONTROL LEVER
Engine Electronic Controller (EEC)
HYDRAULIC SUPPLY
ICU/DCU

GENERAL

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THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER CONTROL - GENERAL

The thrust reverser is primarily controlled by the EEC. In addition to the EEC, there is a second and third layer of protection built in to prevent inadvertent or accidental thrust reverser deployment.

EEC CONTROL

The EEC receives a DEPLOY signal from resolvers in the Thrust Control Unit (TCU) when the throttle control levers are selected to the thrust reverse position. As long as the engine is running, the EEC validates the DEPLOY command and sends a command signal to open the isolation control valve, pressurizing the system. Hydraulic pressure is then directed to the stow side of the door actuators.

EIVMU CONTROL

The DEPLOY command is also controlled by the Engine Interface and Vibration Monitoring Unit (EIVMU). The EIVMU receives the "aircraft on ground" signal from the Landing Gear Control and Interface Unit (LGCIU) and a "thrust reverse selected" signal from a dedicated switch in the TCU. The EIVMU then energizes the Permission Switch, which controls the power supply to the thrust reverser direction control unit. The ground for the relay is controlled by the EEC when the DEPLOY command is validated. Hydraulic pressure is then directed to the hydraulic latches to unlock the reversers and then to the deploy side of the actuators to open the thrust reverser pivoting doors after unlocking the internal (secondary) actuator locks.

FCPC CONTROL

Regulations also require another layer of protection, sometimes referred to as the "third line of defense". This additional protection system must be independently-controlled. In other words, it must use signals different from the EEC/EIVMU control. On the A330, this additional protection is provided by the Tertiary Locking System (TLS). The tertiary locks mechanically lock each pivoting door in the stowed position. The locks are released electrically to deploy the reverser. The TLS is independently controlled by the Flight Control Primary Computers (FCPC 1, 2, 3).
The FCPC command the tertiary locks to unlock when the following conditions are satisfied:
- "thrust reverse selected" signals from dedicated potentiometers in the TCU
- other engine throttle control levers in IDLE position
- "aircraft on ground" - Radio Altimeter (RA) signal < 6 ft.

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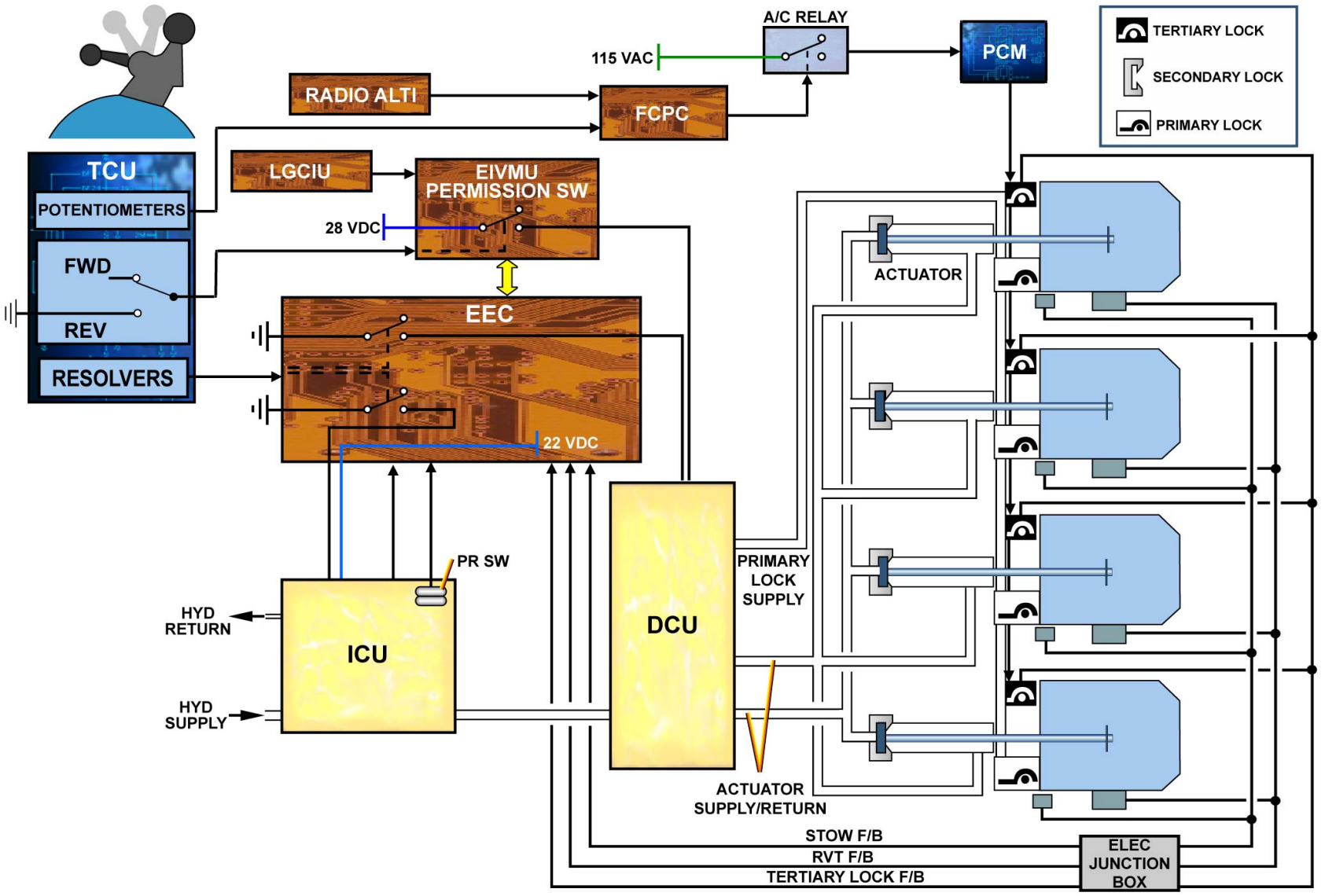

THRUST REVERSER CONTROL - GENERAL - EEC CONTROL ... FCPC CONTROL

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THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER SYSTEM DESCRIPTION

The thrust reverser system on each engine includes:
- four pivoting doors,
- one electrical junction box,
- one Power Conditioning Module (PCM),
- a ground safety switch,
- one stow switch for each pivoting door,
- one actuator for each pivoting door,
- one primary lock for each pivoting door,
- an ICU and DCU,
- one tertiary lock for each pivoting door,
- one Rotational Variable Transducer (RVT) for each pivoting door.

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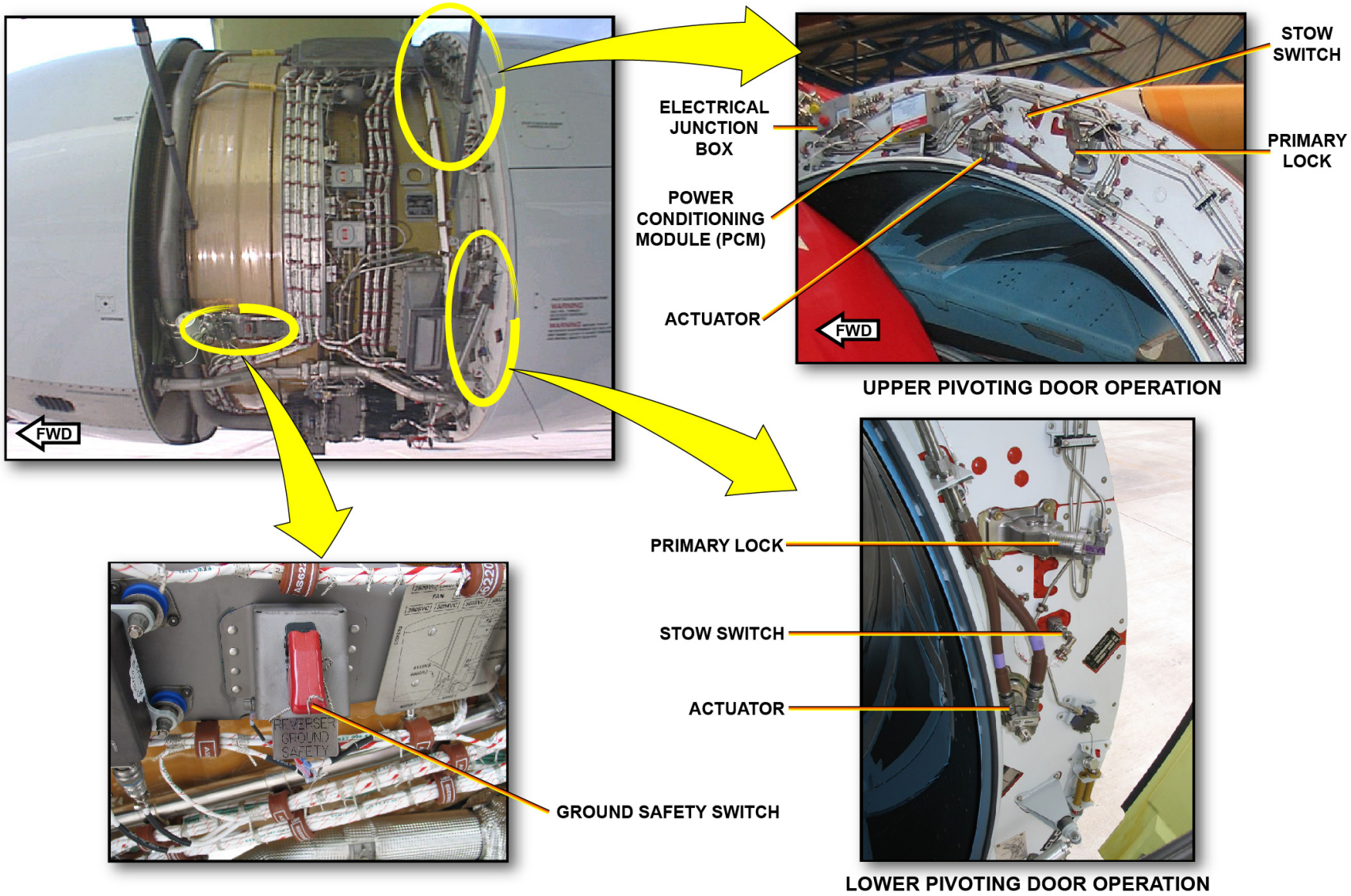
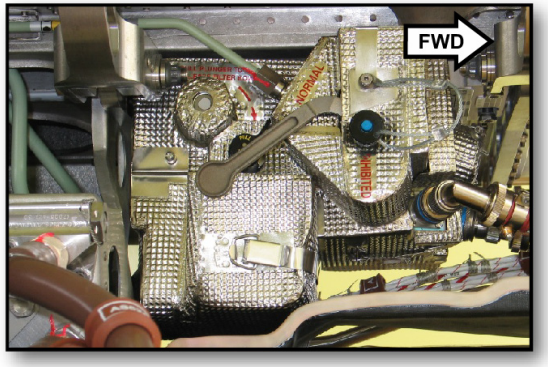
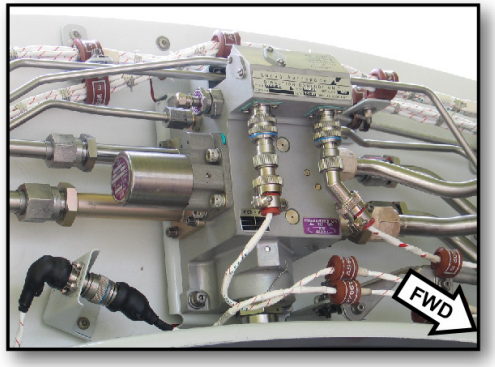


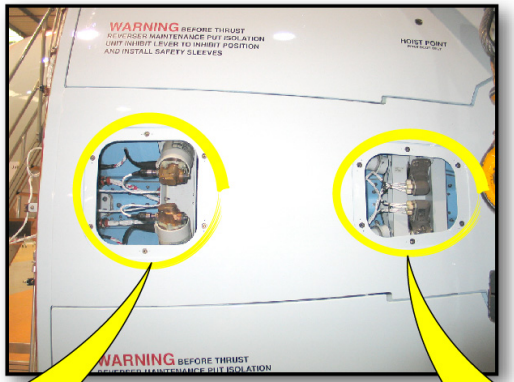
THRUST REVERSER SYSTEM DESCRIPTION

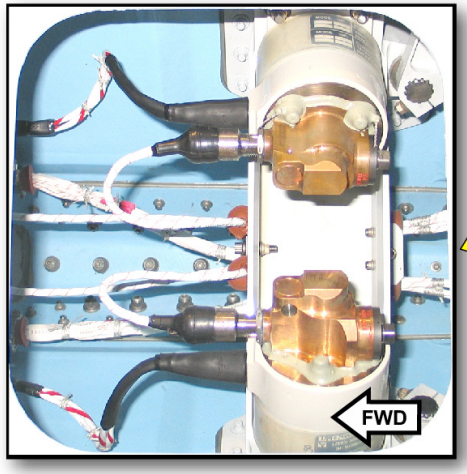


ISOLATION CONTROL UNIT (ICU)



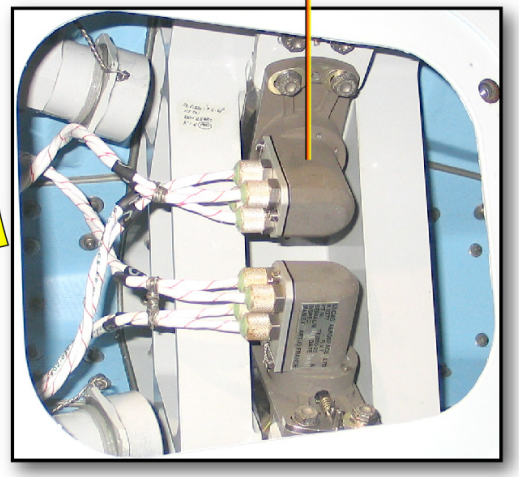
DIRECTION CONTROL UNIT (DCU)





TERTIARY LOCKS (SHOOT BOLTS)

ROTATIONAL VARIABLE TRANSDUCER (RVT)



THRUST REVERSER SYSTEM DESCRIPTION

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THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER HYDRAULIC SYSTEM DESCRIPTION & OPERATION

The thrust reverser is hydraulically supplied by the blue hydraulic system for engine 1, and yellow hydraulic system for engine 2. The thrust reverser hydraulic components control hydraulic fluid flow to the primary locks and pivoting door actuators. Control and feedback signals are exchanged with the engine EEC. The thrust reverser hydraulic components are:
- the ICU with built-in Pressure switch,
- the DCU.

ISOLATION CONTROL UNIT (ICU)

The ICU controls the supply of the hydraulic pressure to the thrust reverser system. When the solenoid is energized by the EEC, the isolation valve opens and supplies pressure through the DCU to the STOW side of the pivoting door actuators. The ICU isolation valve can also be locked with the MANUAL INHIBIT lever to prevent accidental operation of the thrust reverser during maintenance work. The ICU also includes a pressure switch which is pressurized when the isolation valve is open. This actuation of the pressure switch sends a signal to the EEC indicating that the isolation valve is open and that supply pressure is applied to the reverser system.

DIRECTION CONTROL UNIT (DCU)

The DCU solenoid is energized to deploy the thrust reverser. When the solenoid is energized, the DCU supplies hydraulic pressure to the pivoting door primary locks. The locks open in sequence and after the last primary lock is released, return pressure to the DCU moves the direction control valve to the deploy position. The direction control valve controls the pressure to the deploy side of the pivoting door actuators.

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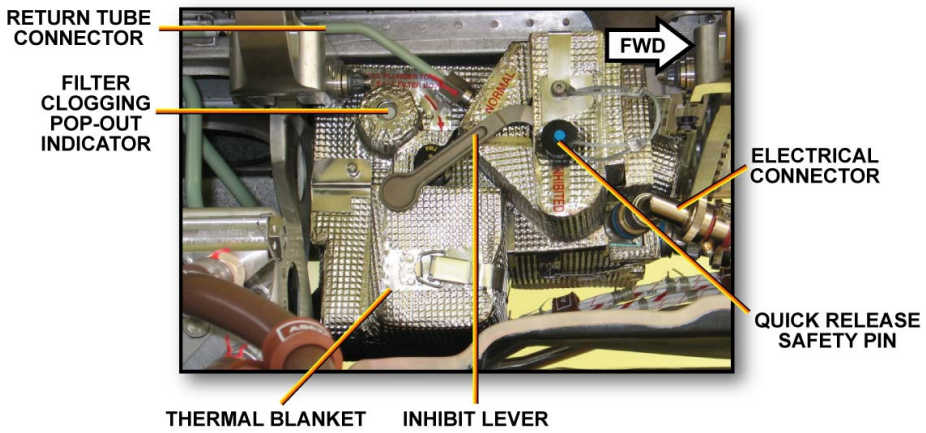

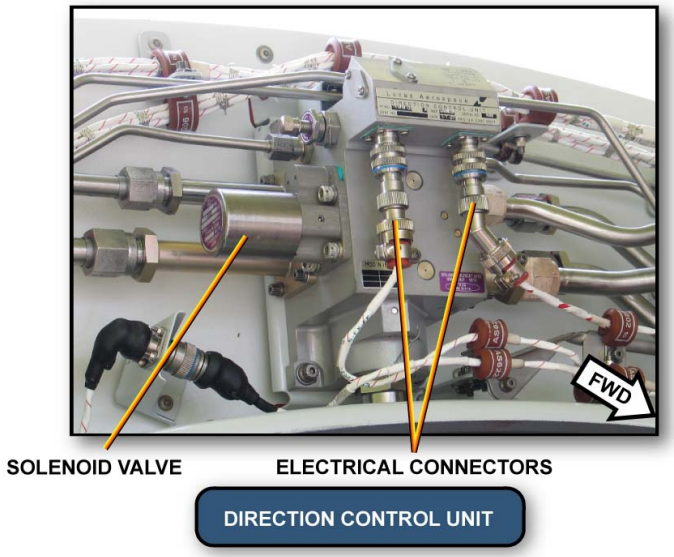

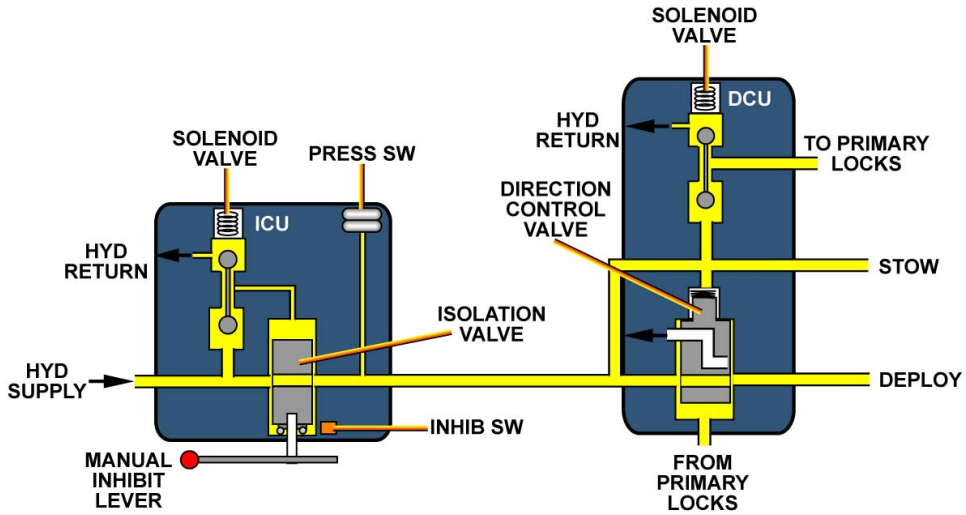

THRUST REVERSER HYDRAULIC SYSTEM DESCRIPTION & OPERATION - ISOLATION CONTROL UNIT (ICU) & DIRECTION CONTROL UNIT (DCU)

THRUST REVERSER SYSTEM D/O (3)

TLS DESCRIPTION AND OPERATION

TLS is an independent electrical locking system that is part of the three lines of defense against inadvertent thrust reverser deployment. There is one tertiary lock for each of the four pivoting doors.
Each tertiary lock is composed of:
- a solenoid assembly
- a mechanical lock assembly

The tertiary lock solenoid is electrically supplied with 115 VAC by PCM to unlock. The power to the PCM is controlled by the FCPC. When the solenoid is energized, the associated shoot bolt moves out of its housing in the hook and the spring actuator assembly moves the hook to the unlock position. Each tertiary lock incorporates a position switch, which provides the lock position signal to the EEC for monitoring purposes.

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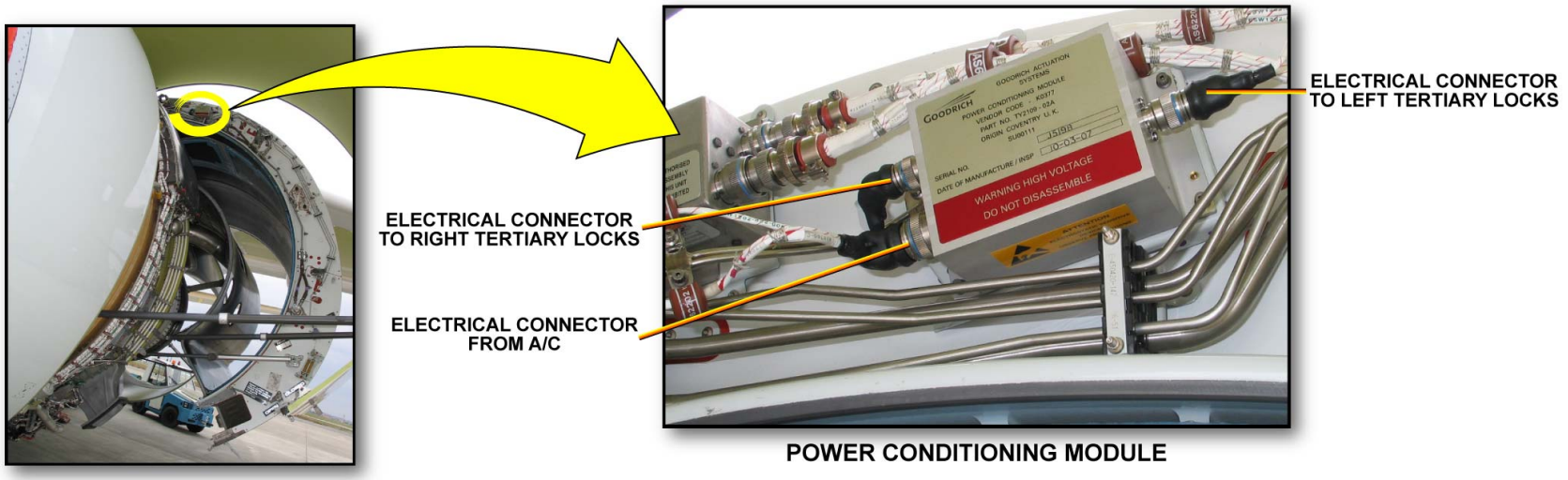

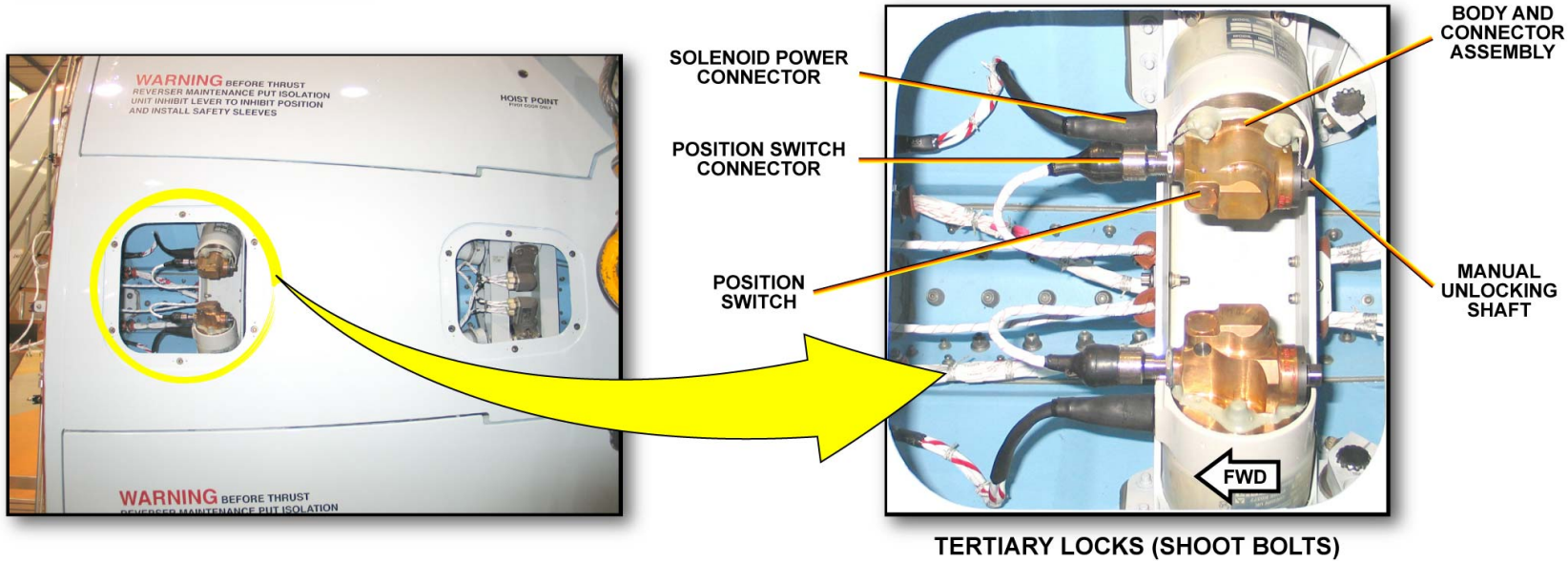

TLS DESCRIPTION AND OPERATION

THRUST REVERSER SYSTEM D/O (3)

OTHER COMPONENTS DESCRIPTION

Each pivoting door is actuated by a hydraulic actuator supplied from the DCU. There is an internal locking mechanism in each actuator, which is the secondary lock for the pivoting door.
For each pivoting door a primary lock is installed on the front frame. The primary locks are locked mechanically when the pivoting door is stowed, and unlocked hydraulically to open.
There is a stow switch and a Rotational Variable Transducer (RVT) for each pivoting door to indicate the door position to the EEC. The stow switches and RVTs send position signals to the EEC through the electrical junction box.
Four inhibition bolts are available to lock the pivoting doors in the stowed position in case of thrust reverser deactivation.
A ground safety switch is installed on the LH fan case and is accessible through an access door in the cowl. The ground safety switch is connected to the EEC and it is installed on the engine so that the maintenance technician can safely operate the thrust reverser during the operational test from the MCDU.

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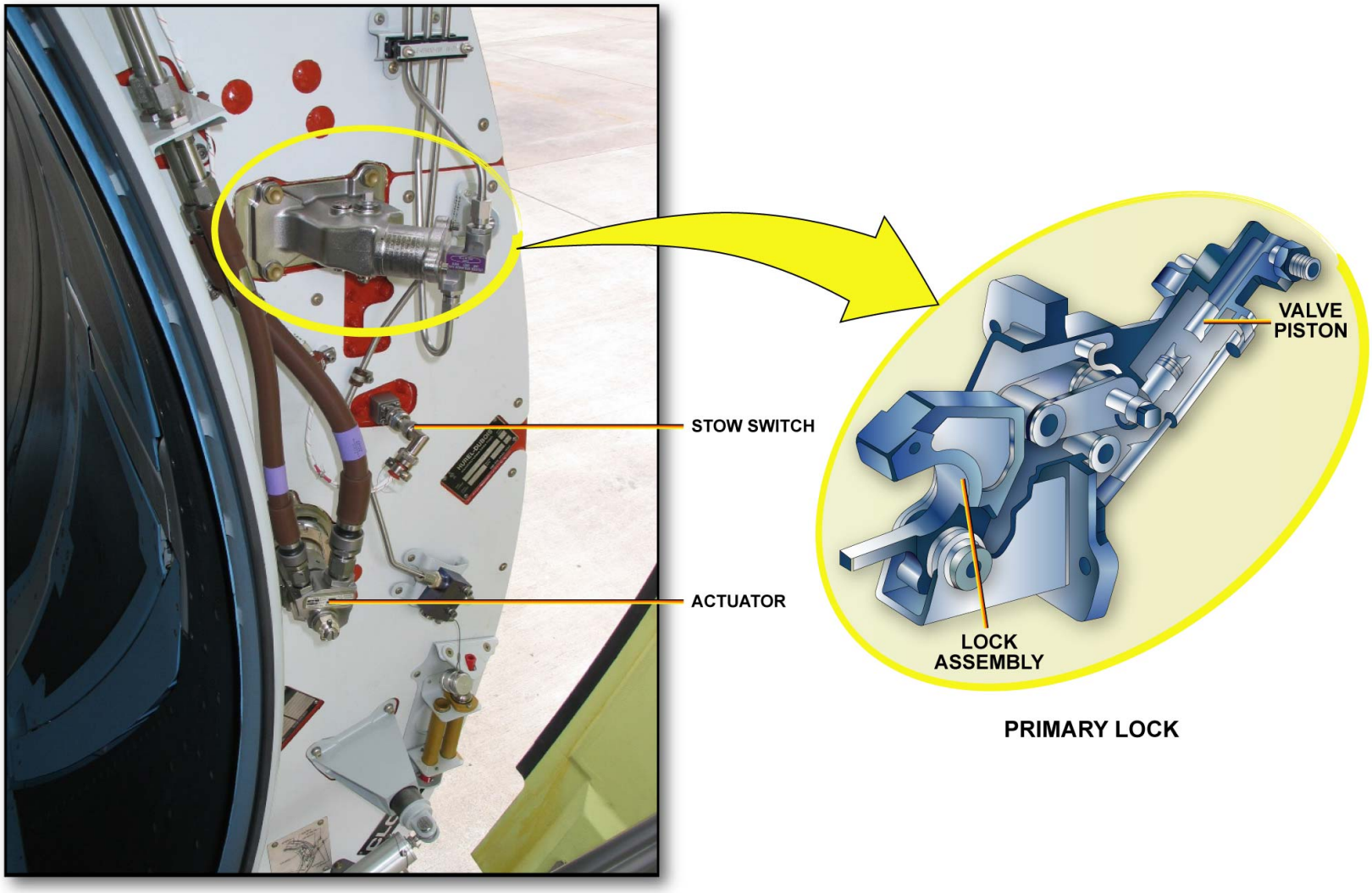

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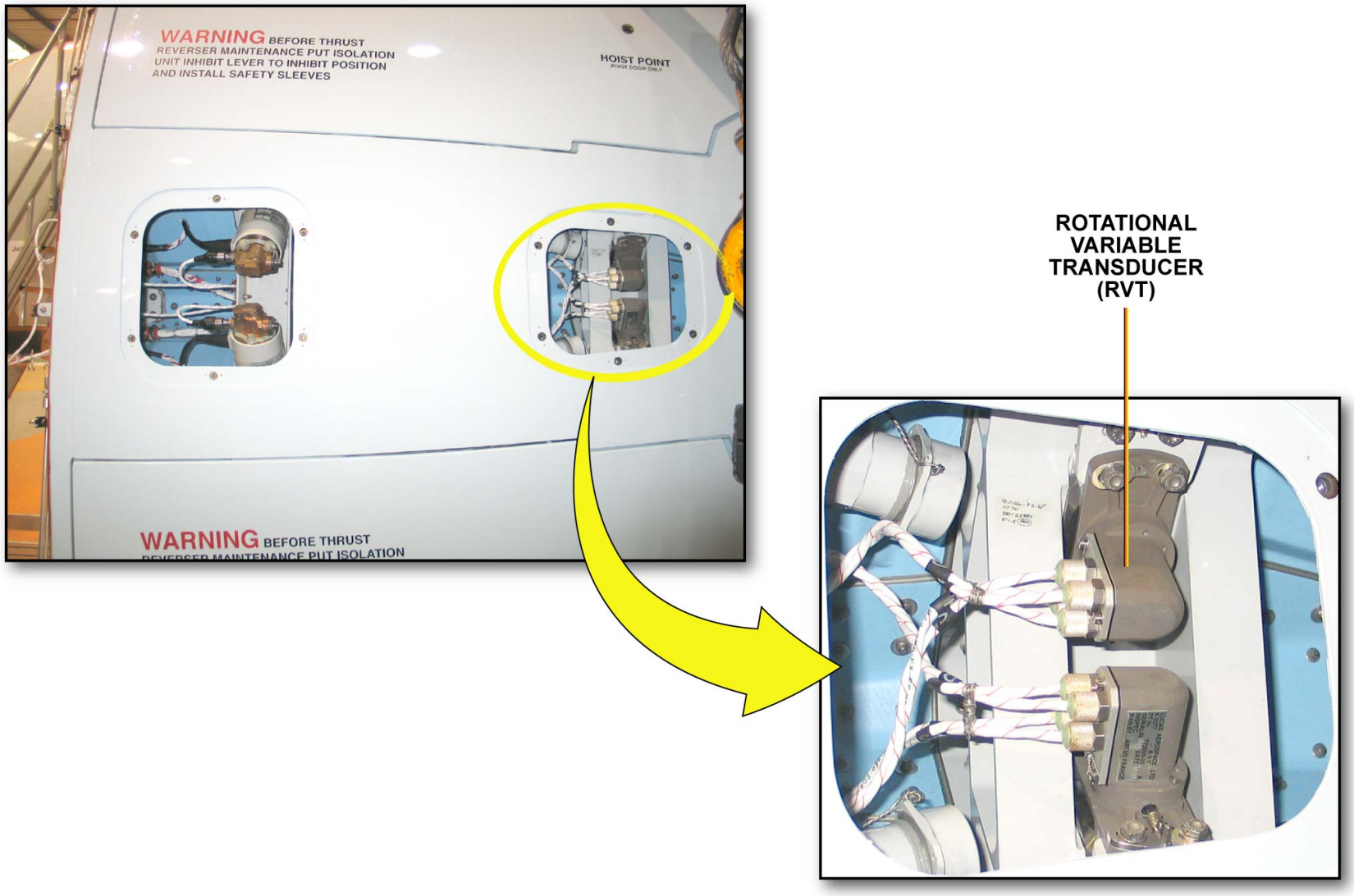

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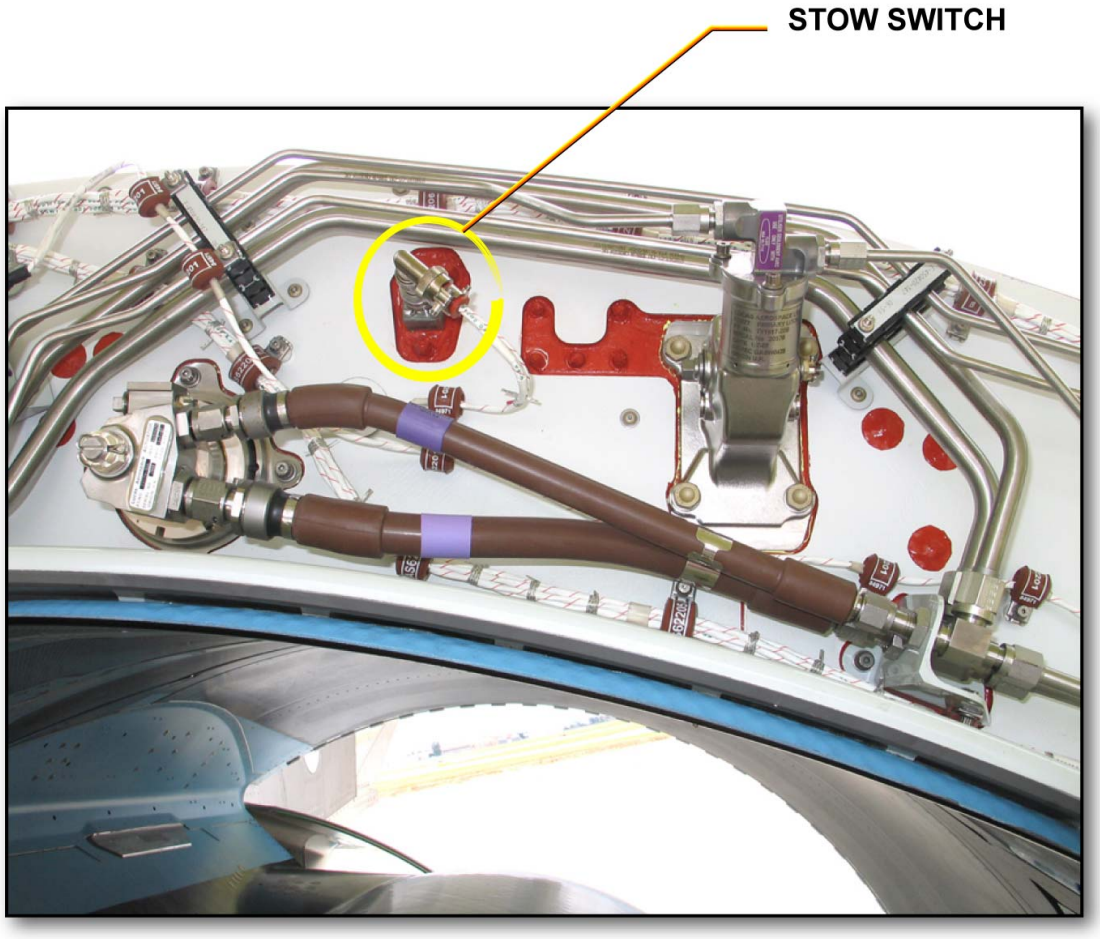

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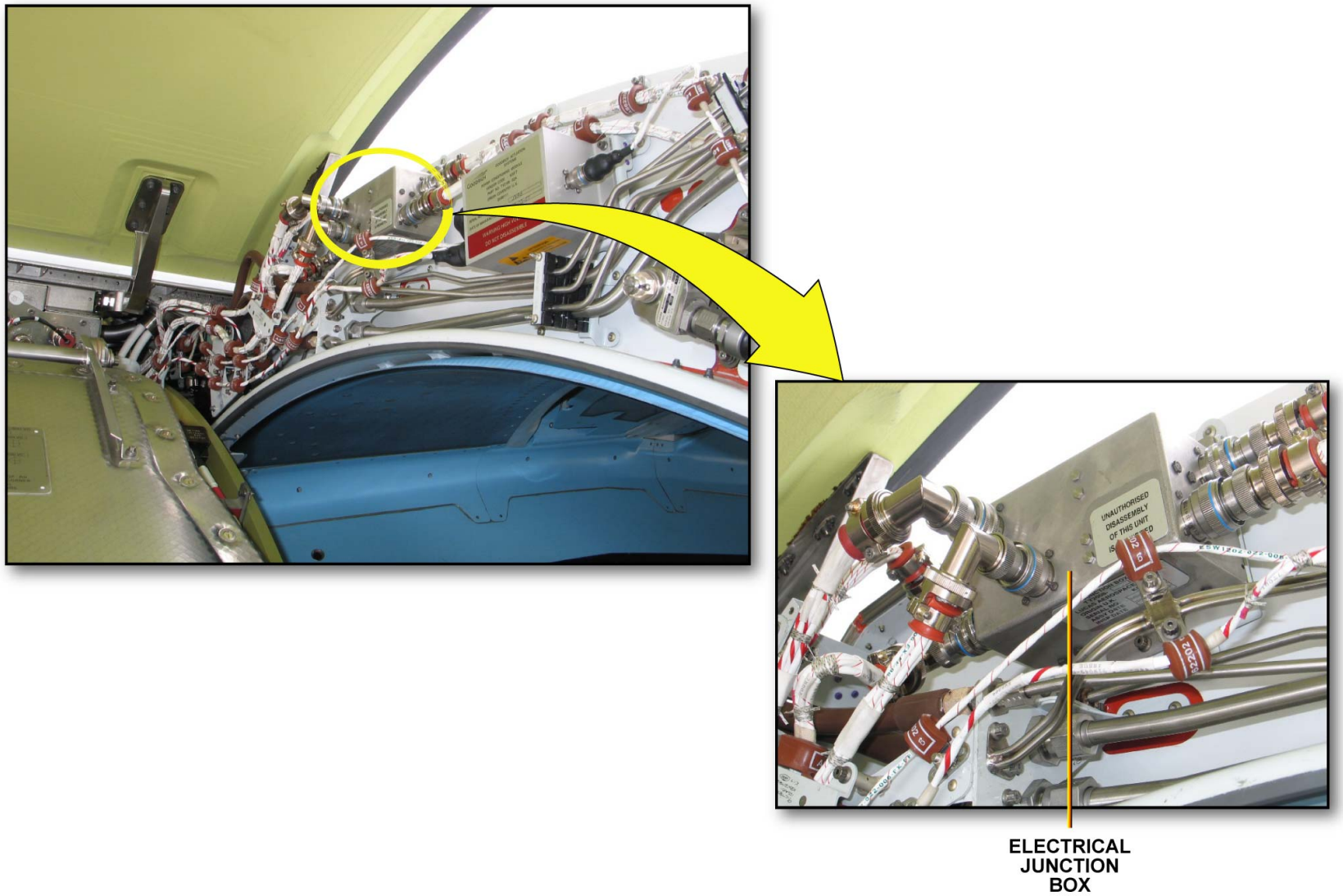
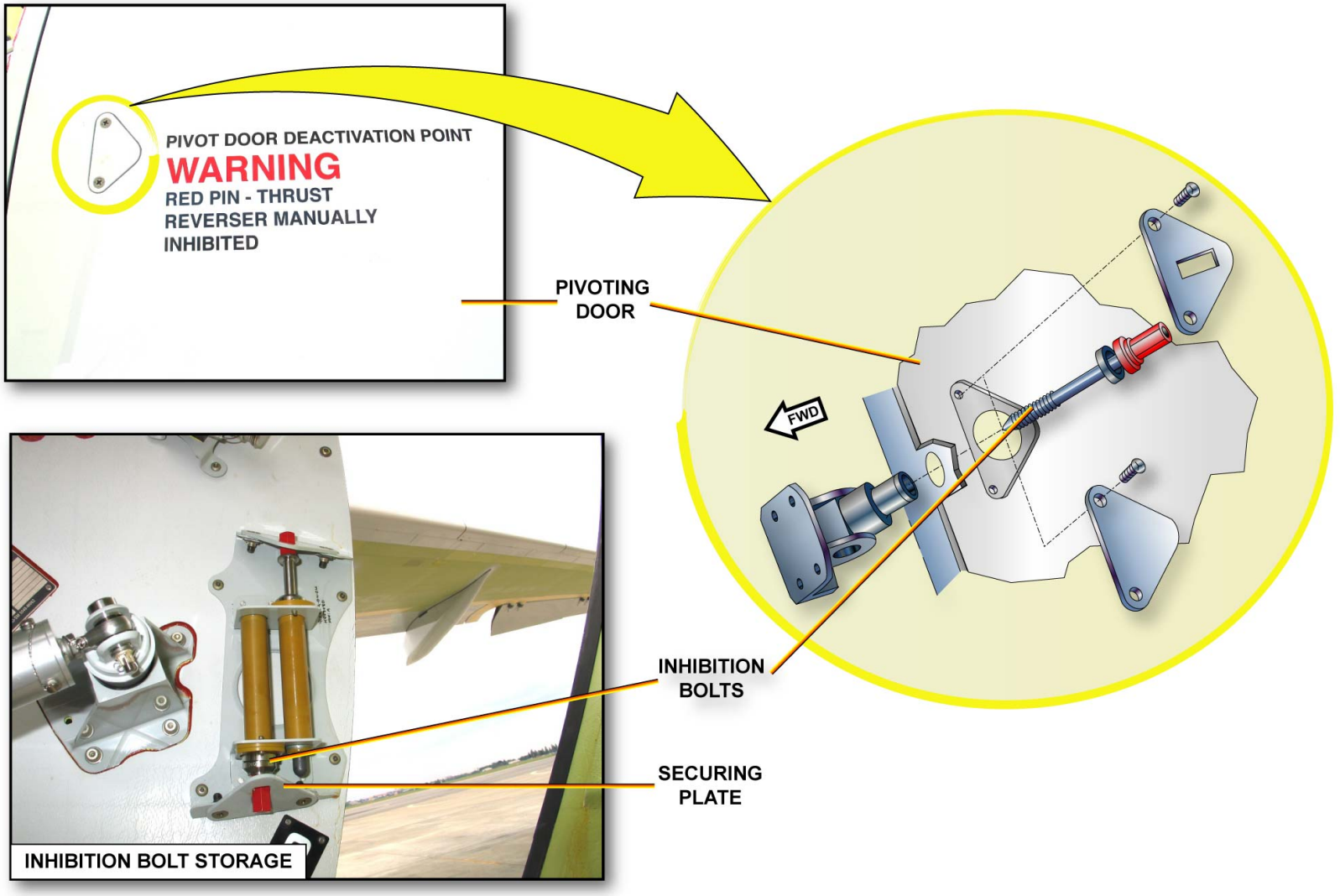
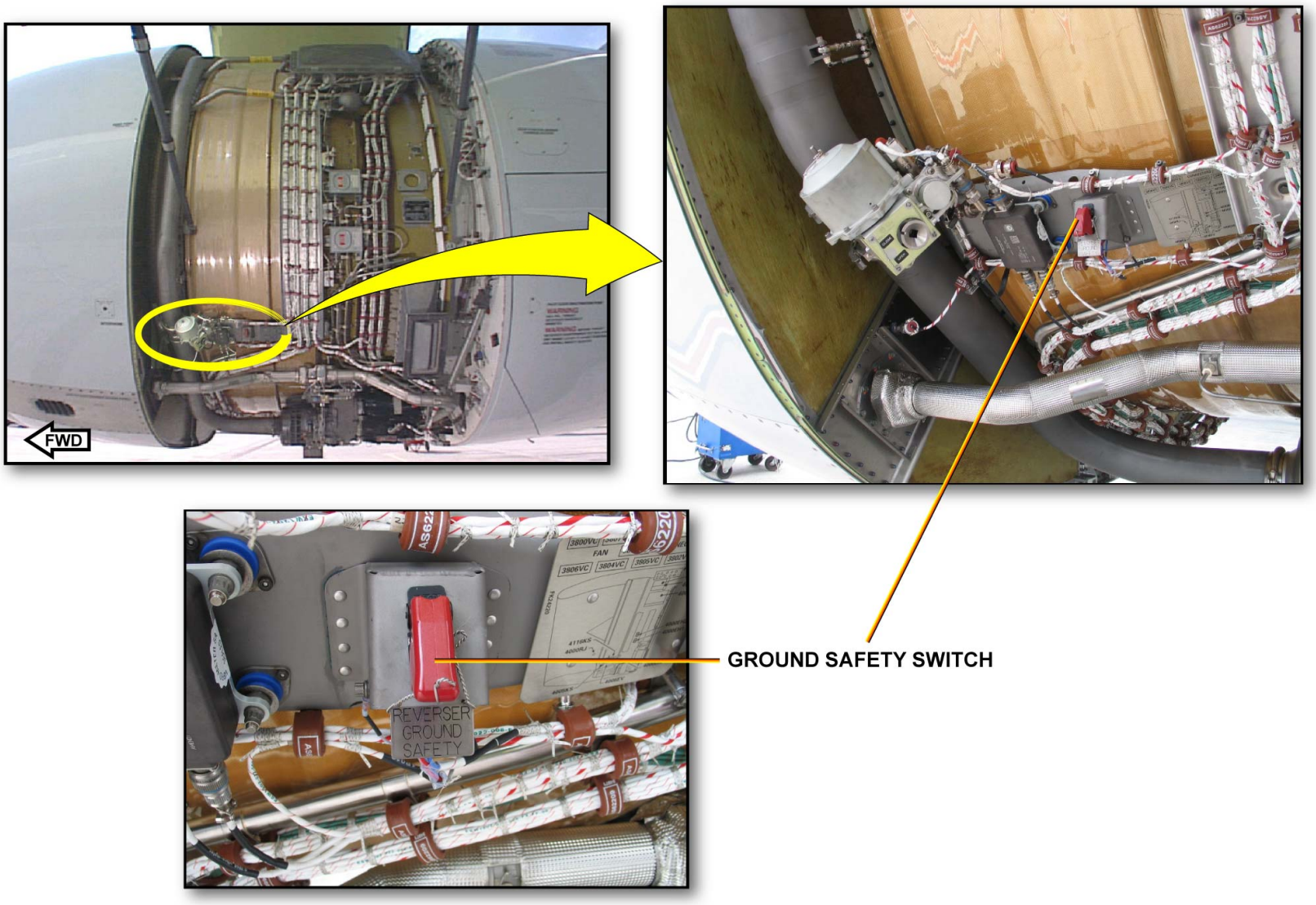


OTHER COMPONENTS DESCRIPTION



OTHER COMPONENTS DESCRIPTION



OTHER COMPONENTS DESCRIPTION

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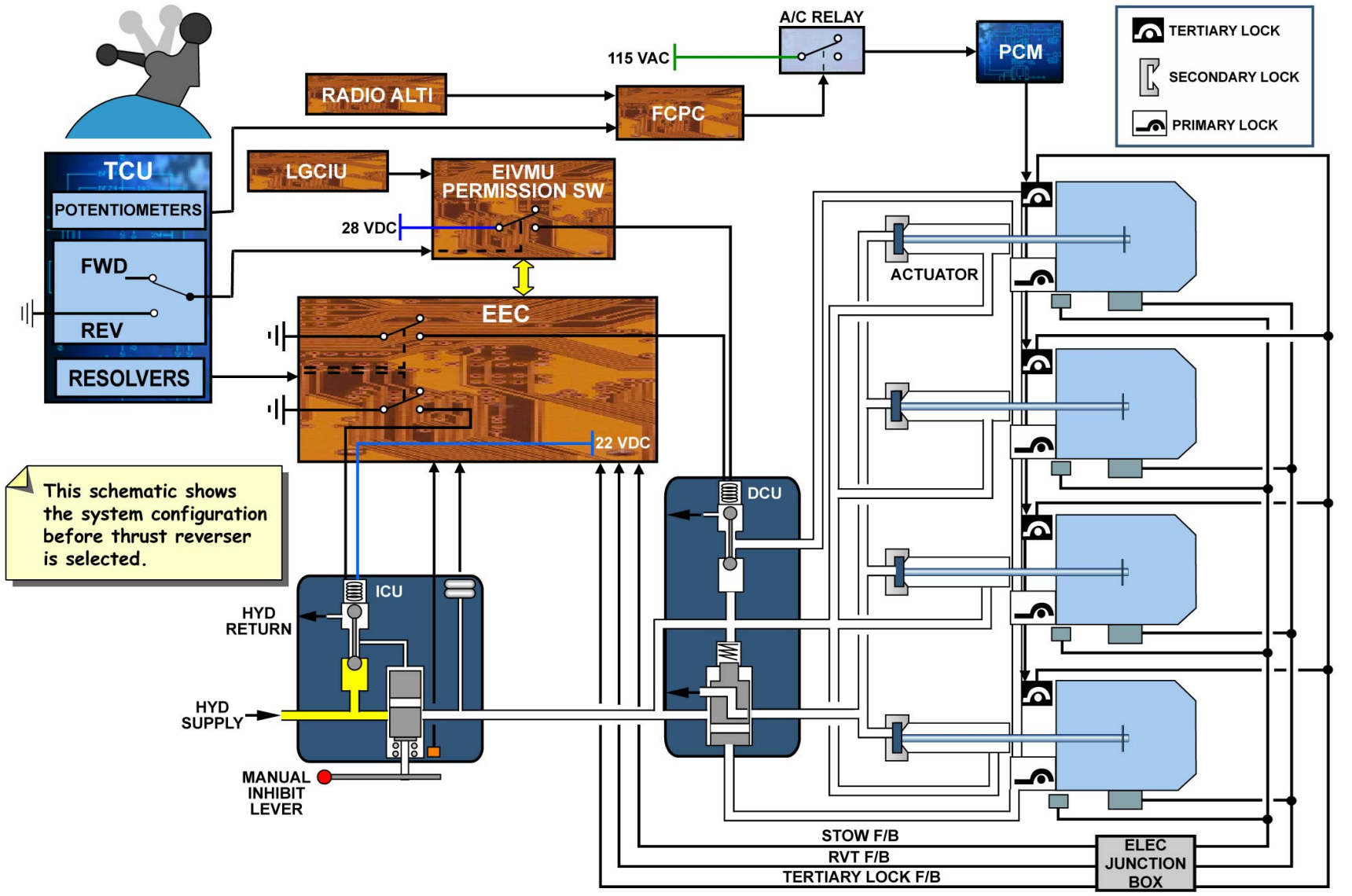
GCL13151 - G6RT1DU - FM70D600000071

THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER OPERATION (DEPLOY SEQUENCE)

The thrust reverser system is only operational when the aircraft is on the ground.

GCL13151 - G6RT1DU - FM70D600000071



THRUST REVERSER OPERATION (DEPLOY SEQUENCE)

GCL13151 - G6RT1DU - FM70D600000071

THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER OPERATION (DEPLOY SEQUENCE) (continued)

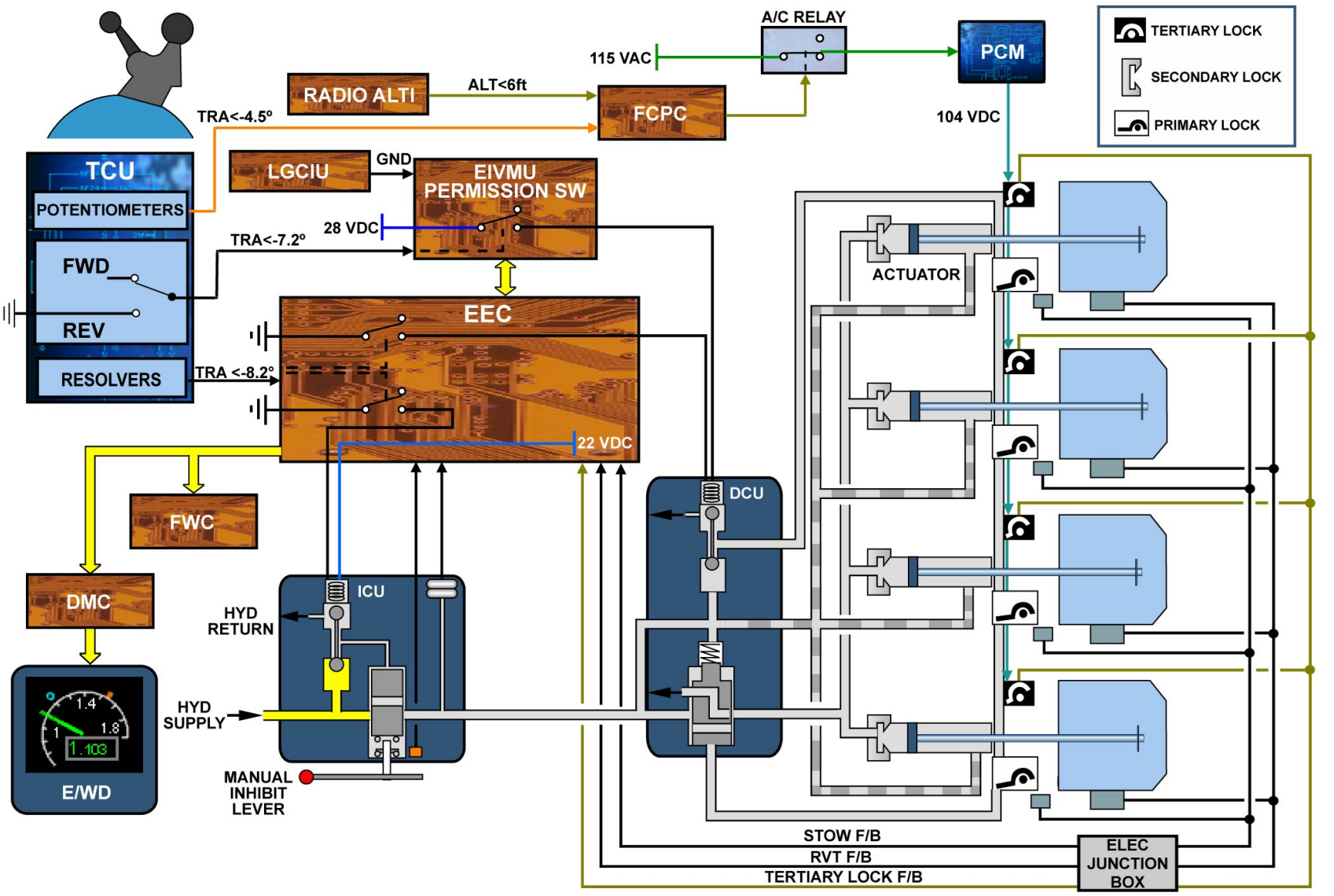
TRANSIT MODE

When the thrust reverse lever is moved to the reverse position with a Throttle Resolver Angle (TRA) reaching -4.5°, the TCU potentiometers send a THRUST REVERSE SELECTED signal to the FCPC. When the FCPC receives the AIRCRAFT on GROUND signal (altitude < 6 feet) from the RA, the FCPC sends a signal to release the tertiary locks.

The TCU also includes a microswitch dedicated to the EIVMU. When the reverse thrust lever reaches the -7.2° position the TCU sends the THRUST REVERSE SELECTED signal to the EIVMU. When the EIVMU receives the AIRCRAFT on GROUND signal from the LGCIU, the EIVMU closes its Permission Switch, which sends 28 VDC power signal to energize the DCU solenoid.

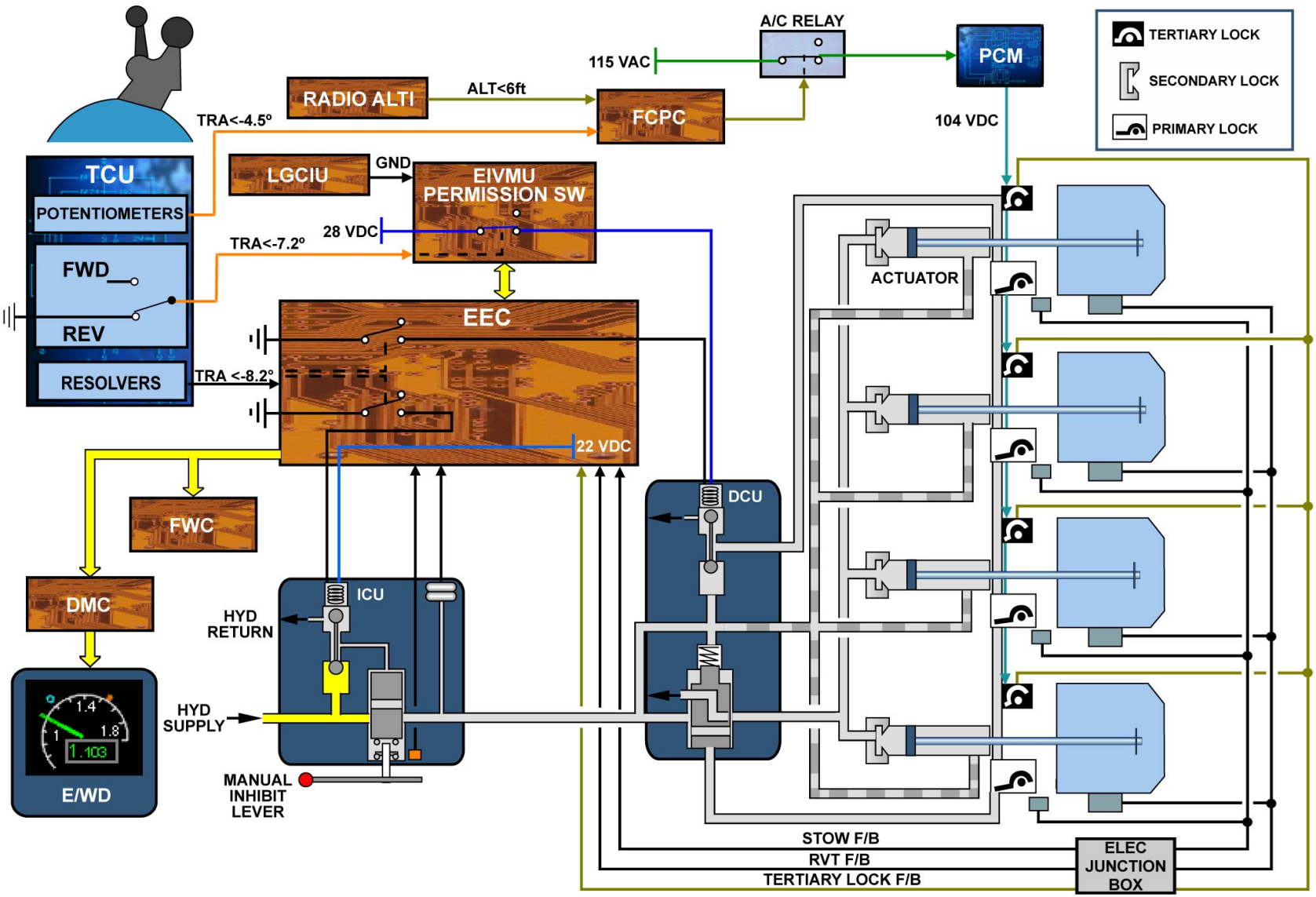
The TCU resolvers also send the THRUST REVERSE SELECTED signal (TRA of -8.2°) to both channels of the EEC. The EEC energizes the ICU solenoid to open the isolation valve. Hydraulic pressure is thus supplied to the DCU. In addition the EEC sends a ground signal to the DCU which is now energized to send hydraulic supply to release the four primary locks in sequence. The hydraulic pressure is also directed to the stow side of the actuators in order to overstow each pivoting door in order to remove the friction on the secondary locks. The opening of the last primary lock sends pressure back to the DCU to open the Direction Control Valve (DCV). When the DCV opens, pressure is directed to the deploy side of the actuators. This pressure releases the internal secondary locks and extends the actuators. The EEC receives the reverser unlocked position signal from the stow switches and the amber "REV" indication is shown on the Engine Pressure Ratio (EPR) indicator on the EWD.

GCL13151 - G6RT1DU - FM70D600000071



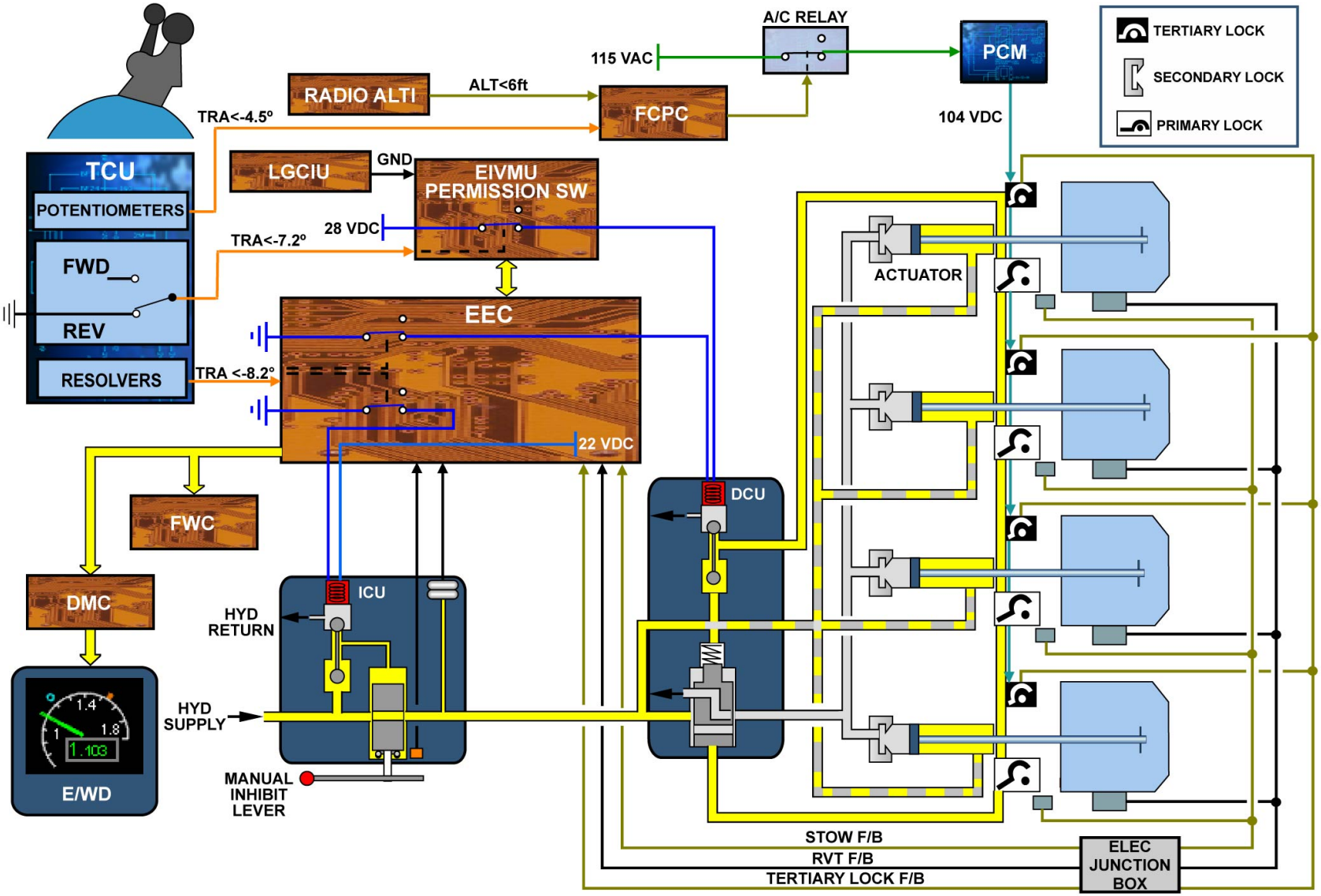
THRUST REVERSER OPERATION (DEPLOY SEQUENCE) - TRANSIT MODE

GCL13151 - G6RT1DU - FM70D600000071



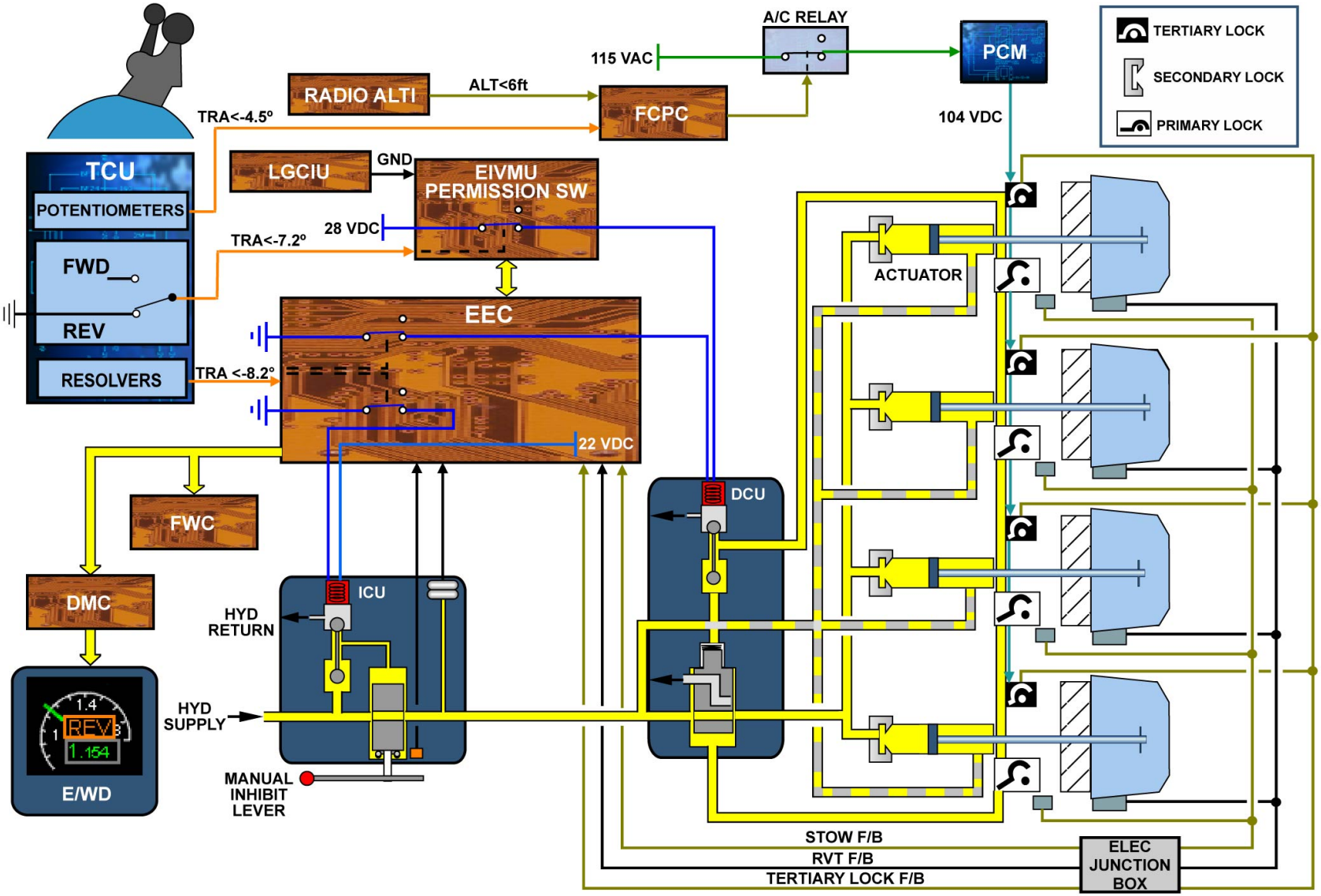
THRUST REVERSER OPERATION (DEPLOY SEQUENCE) - TRANSIT MODE

GCL13151 - G6RT1DU - FM70D600000071



THRUST REVERSER OPERATION (DEPLOY SEQUENCE) - TRANSIT MODE

GCL13151 - G6RT1DU - FM70D600000071



THRUST REVERSER OPERATION (DEPLOY SEQUENCE) - TRANSIT MODE

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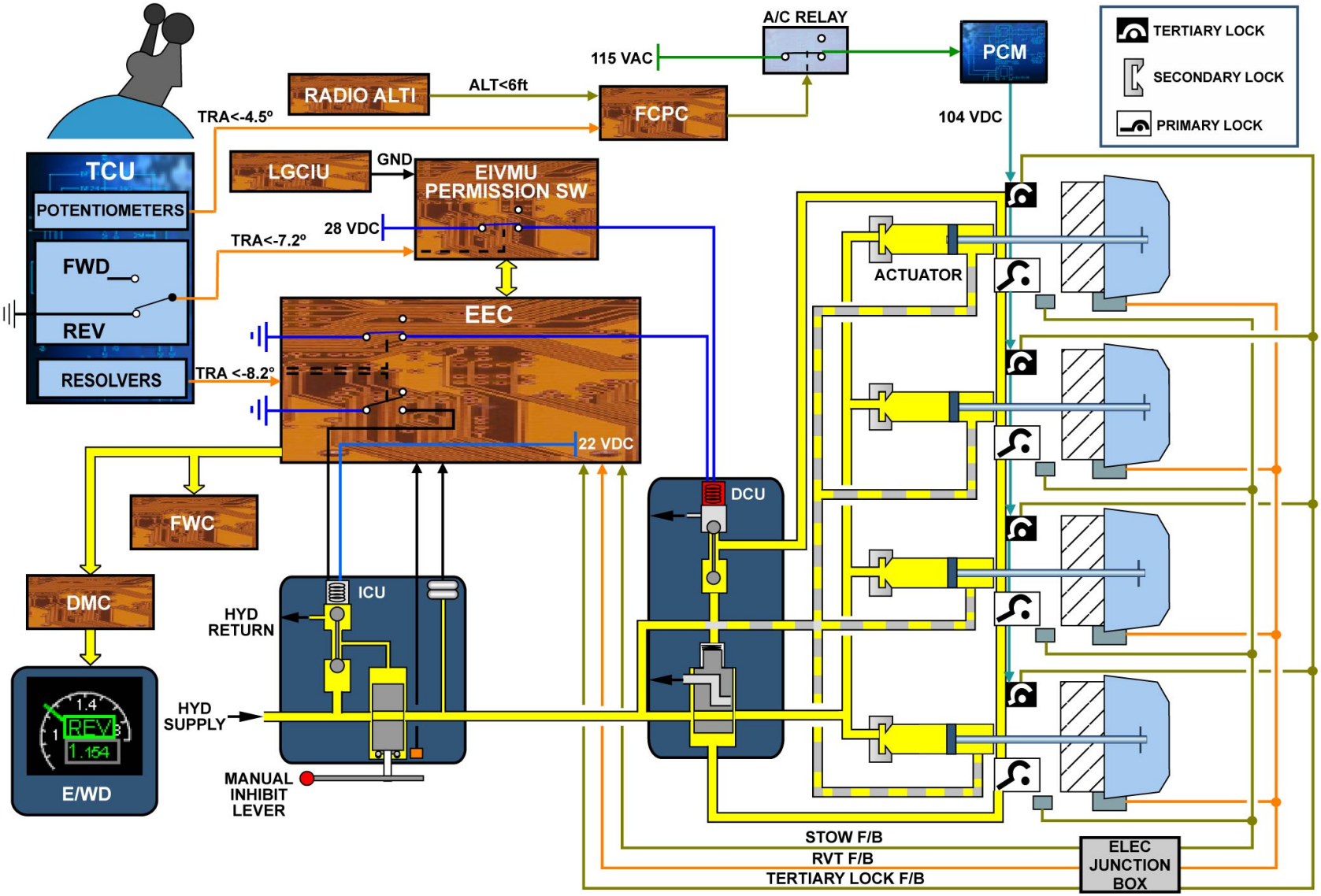
THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER OPERATION (DEPLOY SEQUENCE) (continued)

FULL DEPLOYMENT

The EEC uses the RVT feedback to monitor the movement of the pivoting doors.
Increase in engine power to Max Reverse is progressively available from 70% of deployment to the fully deployed position.
The reverse thrust is managed by the EEC using N1 speed.
When the pivoting doors are at 90% of their fully deployed position, the RVTs send a signal to the EEC and the green "REV" indication replaces the amber indication on the EPR indicator.
Five seconds after the pivoting doors reach 90%, the EEC de-energizes the ICU solenoid, but the DCU solenoid remains energized until the reverse thrust lever is back in the stow position.

GCL13151 - G6RT1DU - FM70D600000071



THRUST REVERSER OPERATION (DEPLOY SEQUENCE) - FULL DEPLOYMENT

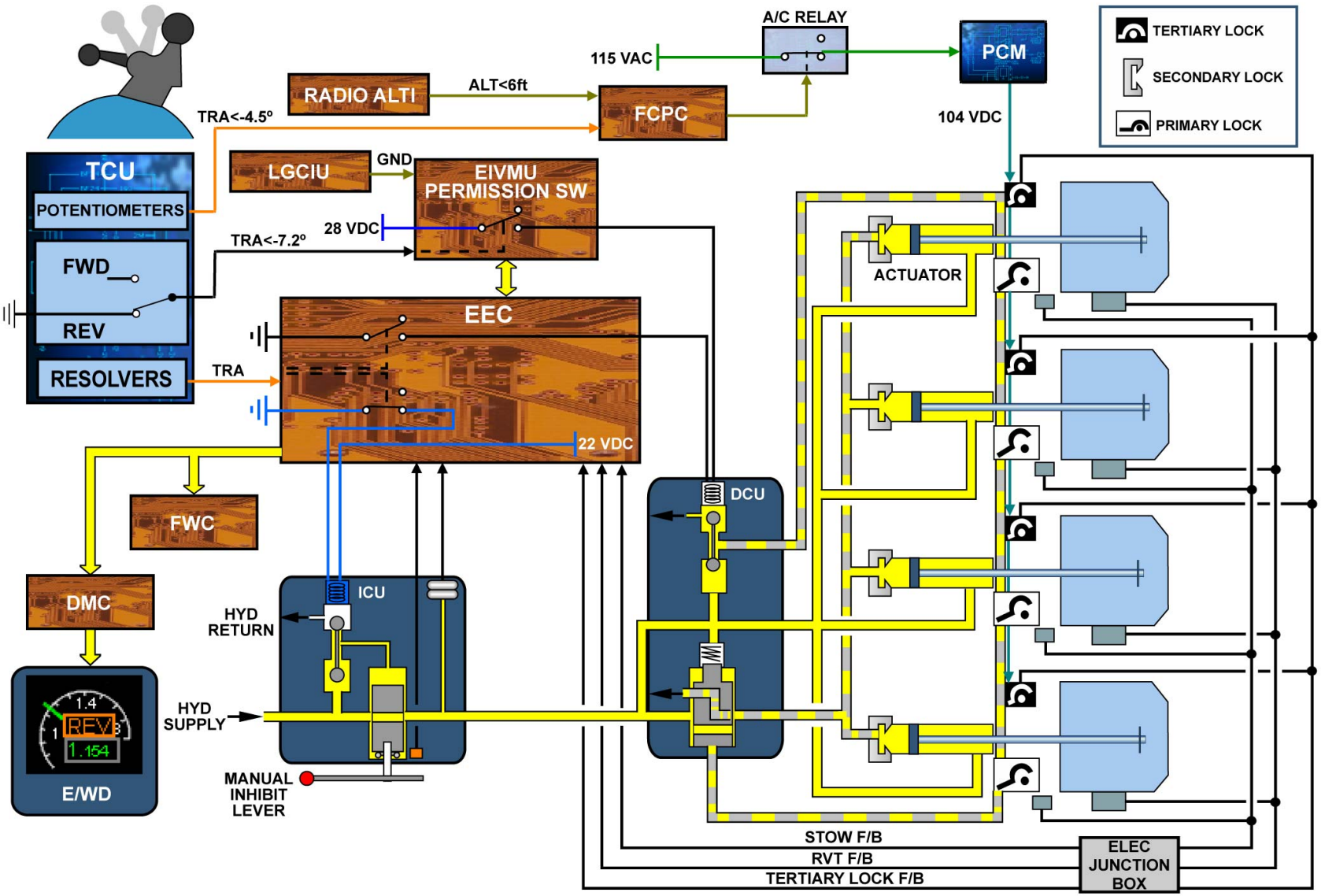
GCL13151 - G6RT1DU - FM70D600000071

THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER OPERATION (STOW SEQUENCE)

When the reverse thrust levers are pushed down to the forward thrust position, the TCU sends a signal to the EEC which energizes the ICU solenoid to open the isolation valve. At the same time, the DCU solenoid is de-energized, which makes the hydraulic pressure go to the stow side of the actuators to close the pivoting doors. The stow transit mode is shown by an amber "REV" indication on the EPR indicator.

GCL13151 - G6RT1DU - FM70D600000071



THRUST REVERSER OPERATION (STOW SEQUENCE)

GCL13151 - G6RT1DU - FM70D600000071

THRUST REVERSER SYSTEM D/O (3)

THRUST REVERSER OPERATION (STOW SEQUENCE) (continued)

STOW POSITION

The pivoting doors go to the overstow position to enable the primary, secondary and tertiary locks to engage mechanically. The doors will return to the normal stow position once the EEC has de-energized the ICU solenoid to shut off the hydraulic supply. The EEC, using feedback signals from the stow switches and RVTs, confirms the reverser stowed condition and the amber "REV" indication disappears from the EPR indicator. The ICU solenoid is de-energized when the doors are confirmed stowed for more than 5 seconds, and the tertiary locks are de-energized when the TRA > -4.5° for more than 15 seconds.

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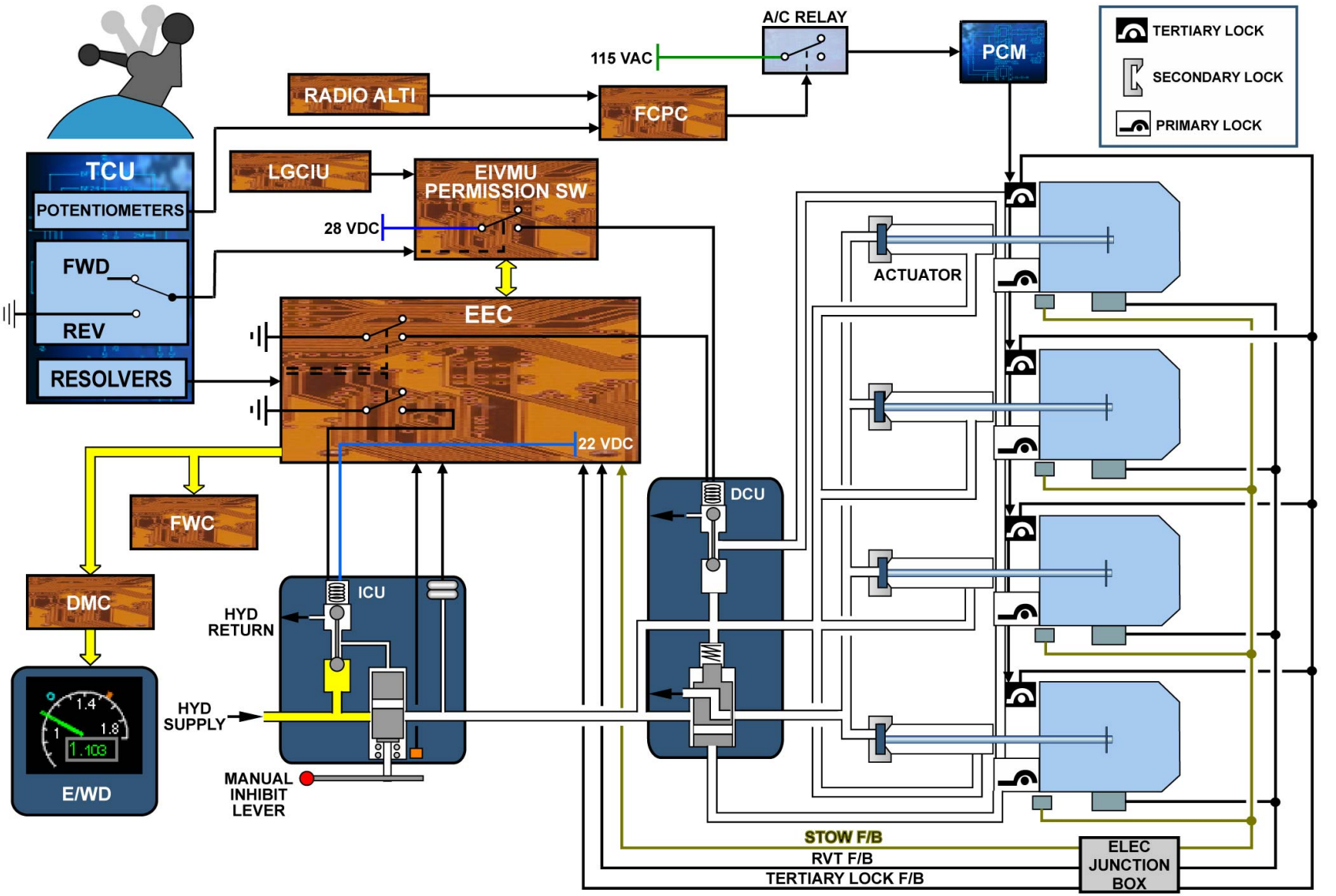

THRUST REVERSER OPERATION (STOW SEQUENCE) - STOW POSITION

GCL13151 - G6RT1DU - FM70D600000071

THRUST REVERSER SYSTEM D/O (3)

ABNORMAL OPERATIONS

In case of thrust reverser abnormal operation, various warnings are triggered on ECAM as follows:
"REV UNLOCKED" is triggered if one of the reverser pivoting doors is unlocked in the stowed position with no deploy order.
As a result the EEC limits the thrust of the affected engine to idle.
"REV FAULT" is triggered in case of:
- autorestow,
- aircraft ground/ flight information failure,
- loss of power supply on both DCU channels,
- EIVMU permission switch failed closed,
- class 1 thrust reverser fault.

As a result the EEC limits the thrust of the affected engine to idle.
"REV PRESSURIZED" is triggered if the thrust reverser system is pressurized while the reverser pivoting doors are stowed and locked with no deploy order.
As a result the EEC limits the thrust of the affected engine to idle.
"REV INHIBITED" appears if the thrust reverser system is locked in the stowed position by maintenance action.
"REV SET" appears if the reverse thrust is selected in flight.

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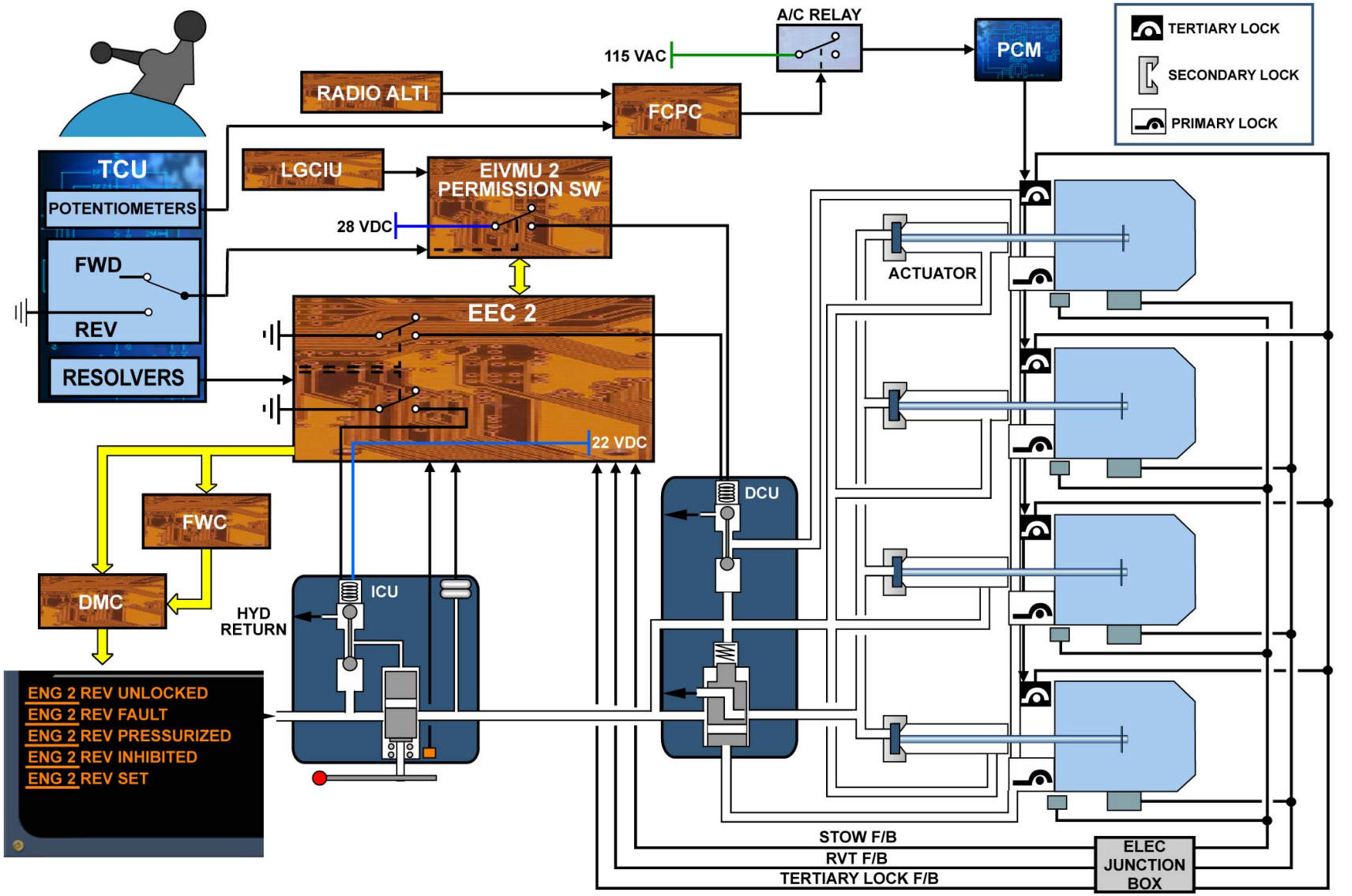

ABNORMAL OPERATIONS

GCL13151 - G6RT1DU - FM70D600000071

OIL SYSTEM D/O (3)

GENERAL

The primary function of the oil system is to supply sufficient oil at the correct temperature and pressure to the engine internal drives, gears and bearings for lubrication, to decrease temperature and keep wear to a minimum. The oil system is also designed to heat the fuel to prevent fuel icing.

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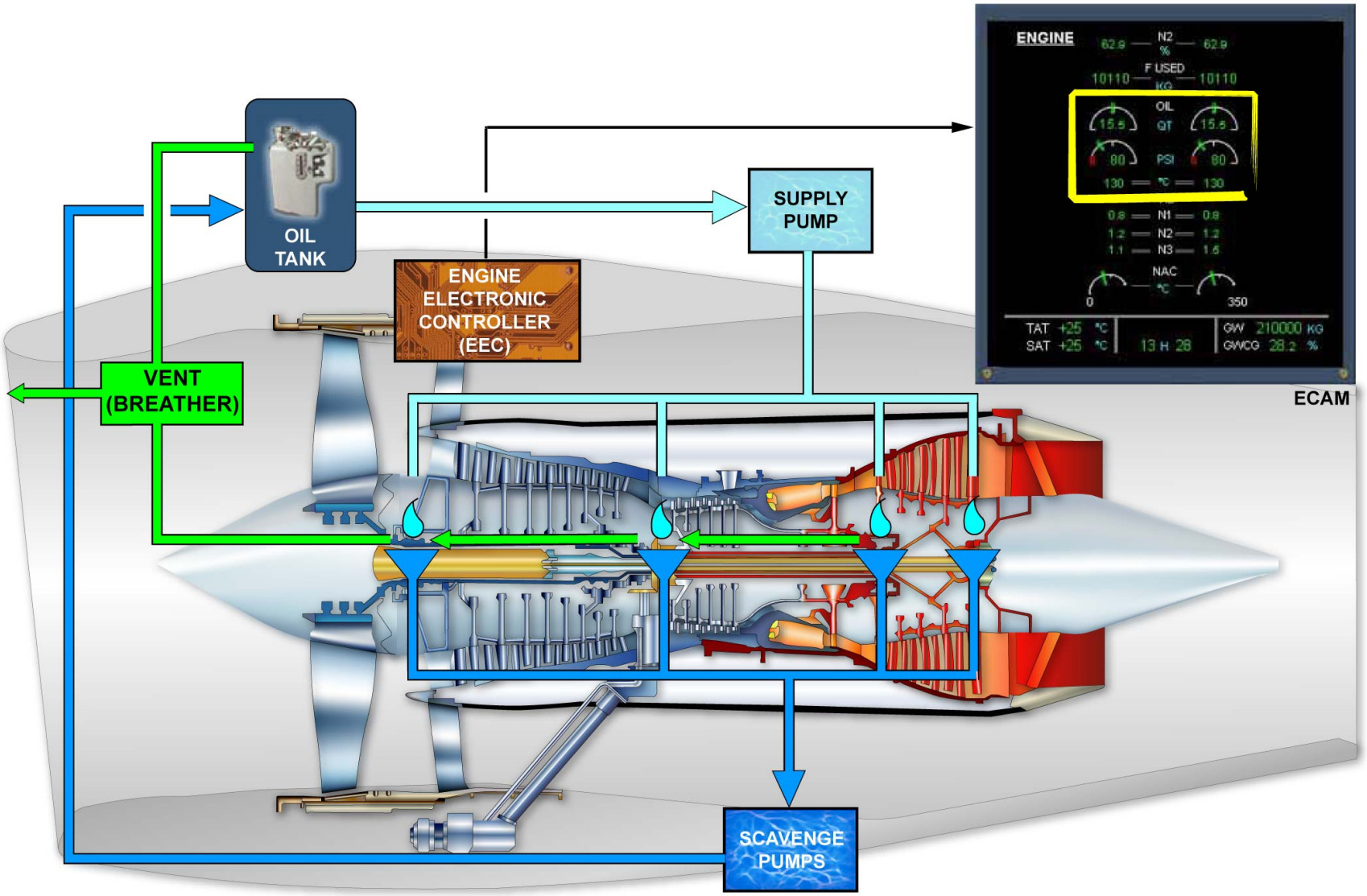

GENERAL

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

DESCRIPTION

The oil system is composed of different items.

OIL TANK

The oil tank is attached to the Low Pressure (LP) compressor case, on the right side of the engine. It stores the oil used by the engine to lubricate and cool the bearings and gears. It can be replenished by gravity from the oil filler cap and has a maximum total capacity of 23.7 litres. A sight-glass installed on the side of the oil tank gives a visual indication of the oil level.

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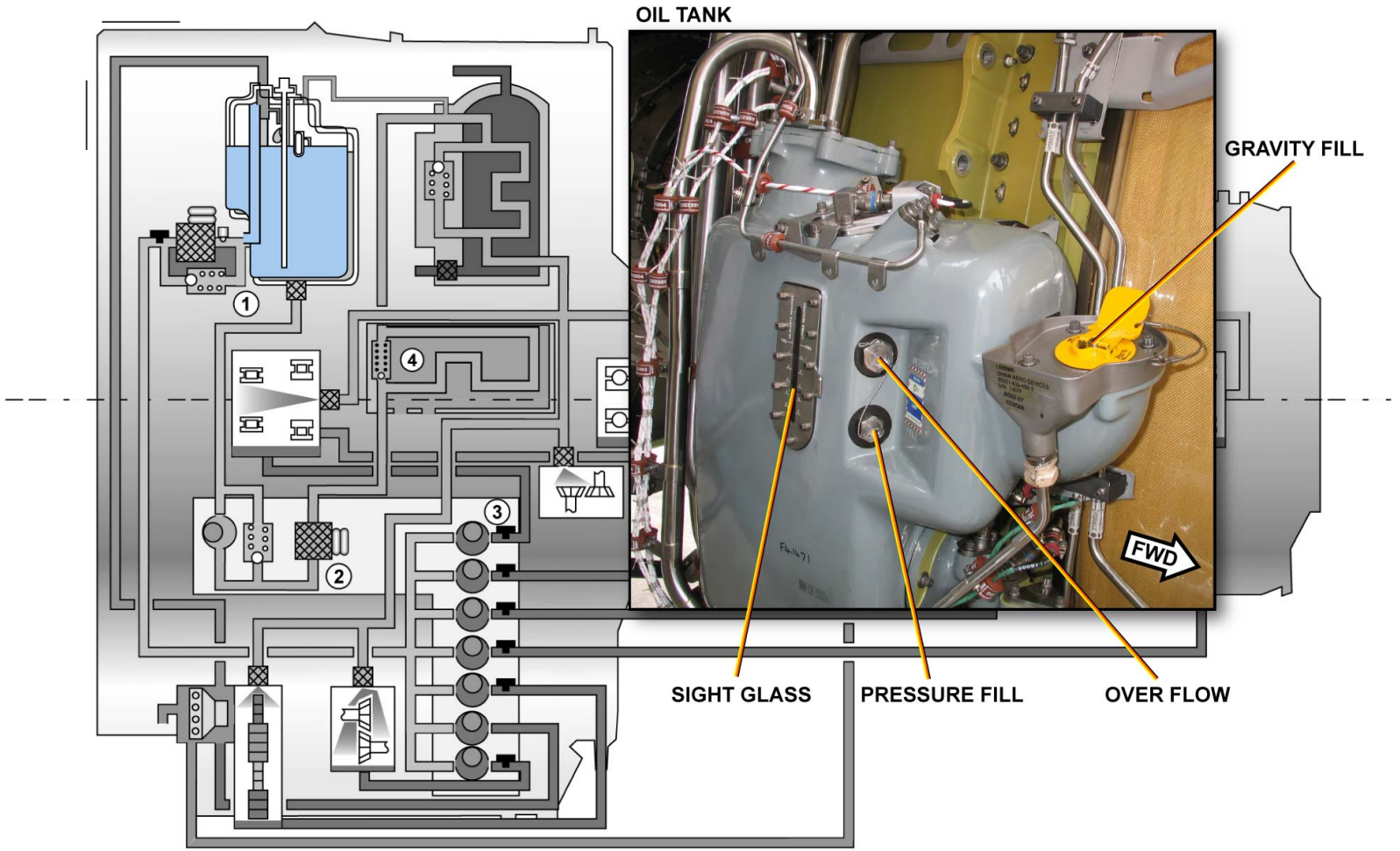

DESCRIPTION - OIL TANK

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

OIL QUANTITY TRANSMITTER

The oil quantity transmitter is an assembly, and includes:
- a tube with holes along its length to let the oil in the transmitter be measured,
- a Printed Circuit Board (PCB) with switches and resistors in rows attached along the length of the inner tube surface,
- a float assembly that contains two magnets.

As the float assembly moves the PCB up or down, the magnets cause the adjacent switch on the PCB to close. This changes the voltage and thus the signal sent to the Engine Electronic Controller (EEC) channel A. It is calibrated to give a value of:
- 6V DC if the tank is full.
- 0V DC if the tank is empty.

An anti-siphon device prevents oil from draining by gravity from the tank to the pump into the gearbox after engine shut down. It uses air from the tank.

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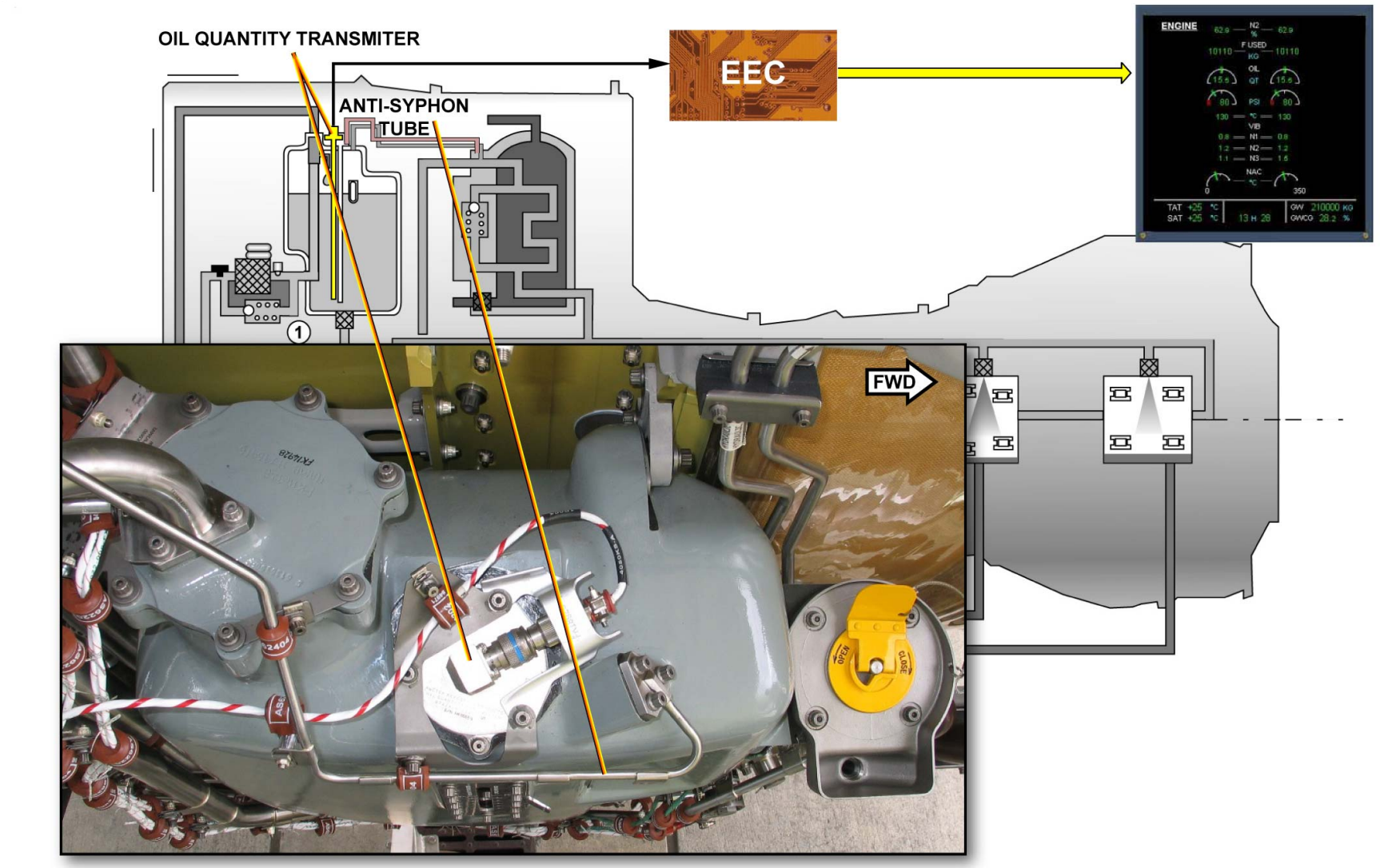

DESCRIPTION - OIL QUANTITY TRANSMITTER

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

OIL PUMP ASSEMBLY

Oil pump assembly is installed on the rear face of the external gearbox. It has eight gyrotor type pumps. There is one pressure section pump unit, which raises the oil pressure to the bearings and gears. There are also seven scavenge section pump units, which scavenge oil from the various areas of the engine back to the oil tank. The pump units are assembled into a pump stack on a single drive shaft.

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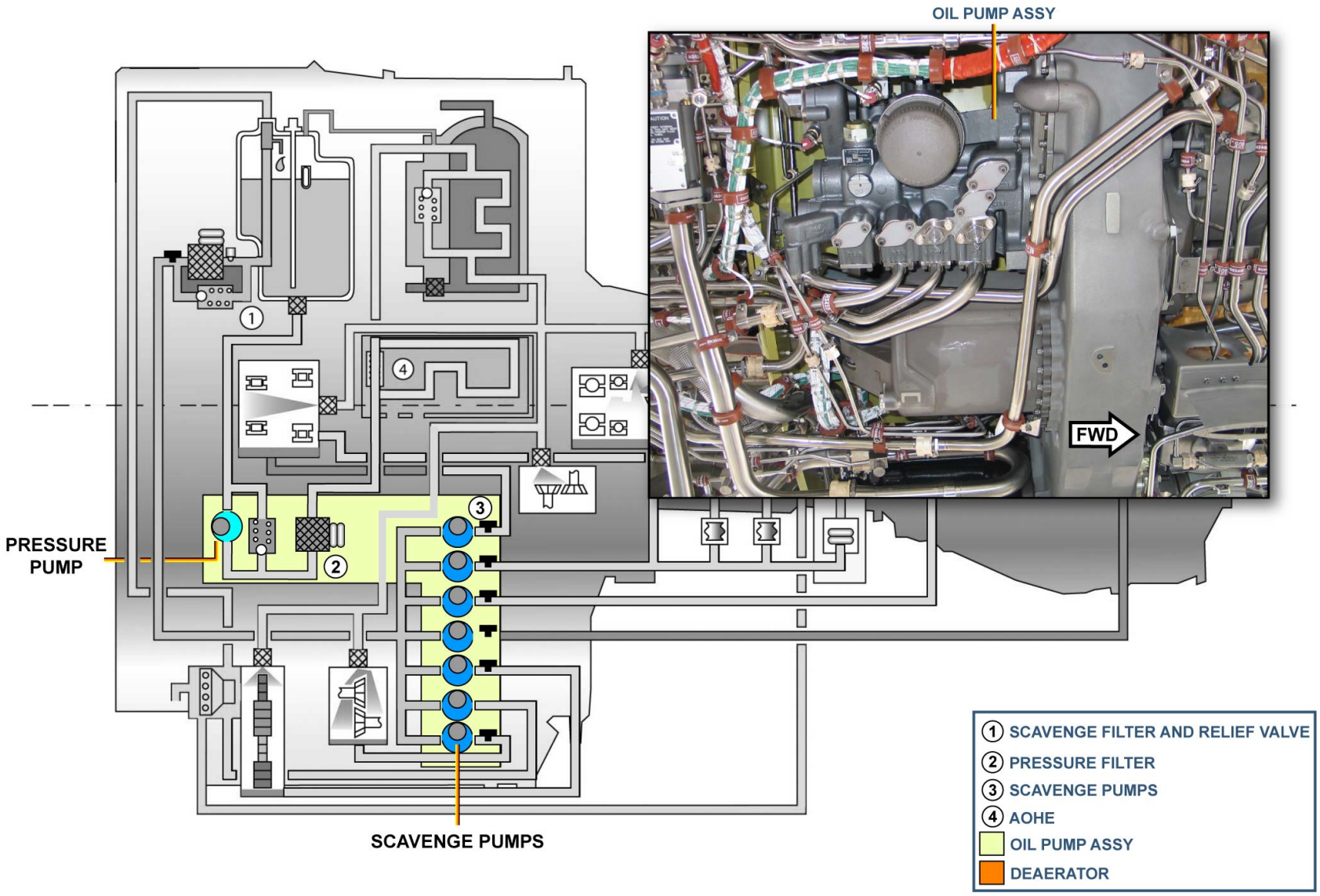

DESCRIPTION - OIL PUMP ASSEMBLY

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

COLD START PRESSURE RELIEF VALVE

The cold start pressure relief valve is installed downstream of the pressure pump mechanism side. It protects the oil system by relieving the pressure back to the pump inlet, when exceeding 580 PSID. The valve is normally closed during engine operation, and will only open with a cold oil condition or blockage of the system.

PRESSURE FILTER AND PRESSURE FILTER DIFFERENTIAL PRESSURE SWITCH

The pressure oil filter is installed at the bottom of the oil pump assembly in filter housing and contains a 145-micron filter element. The element is of metal type and can be removed and examined. After inspection it can be cleaned and used again providing it is not damaged. A pressure filter differential pressure switch, installed on the filter housing, contains a differential pressure sensitive mechanism, which monitors the filter condition.

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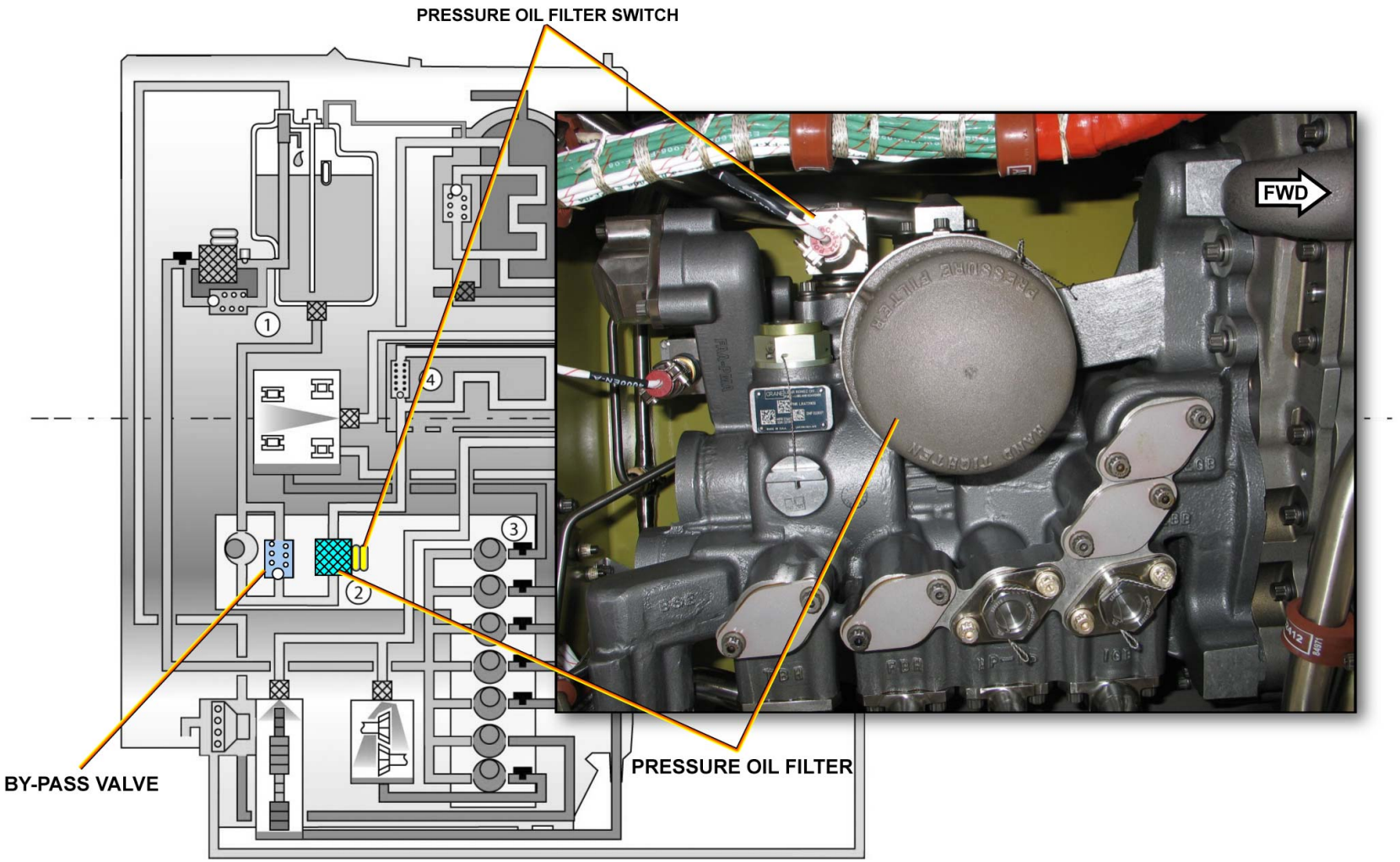

DESCRIPTION - COLD START PRESSURE RELIEF VALVE & PRESSURE FILTER AND PRESSURE FILTER DIFFERENTIAL PRESSURE SWITCH

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

AIR OIL HEAT EXCHANGER (AOHE)

The Air Oil Heat Exchanger (AOHE) is installed on the lower right hand side of the fan case below the oil tank. The AOHE is divided into two main parts:
- a heat exchanger assembly which keep the engine oil and fuel temperature in specified limits (to give the best engine performance), so, when necessary, LP compressor air is used to decrease the oil temperature,
- a air modulating valve assembly which adjusts the type and quantity of compressor airflow across the heat exchanger assembly.

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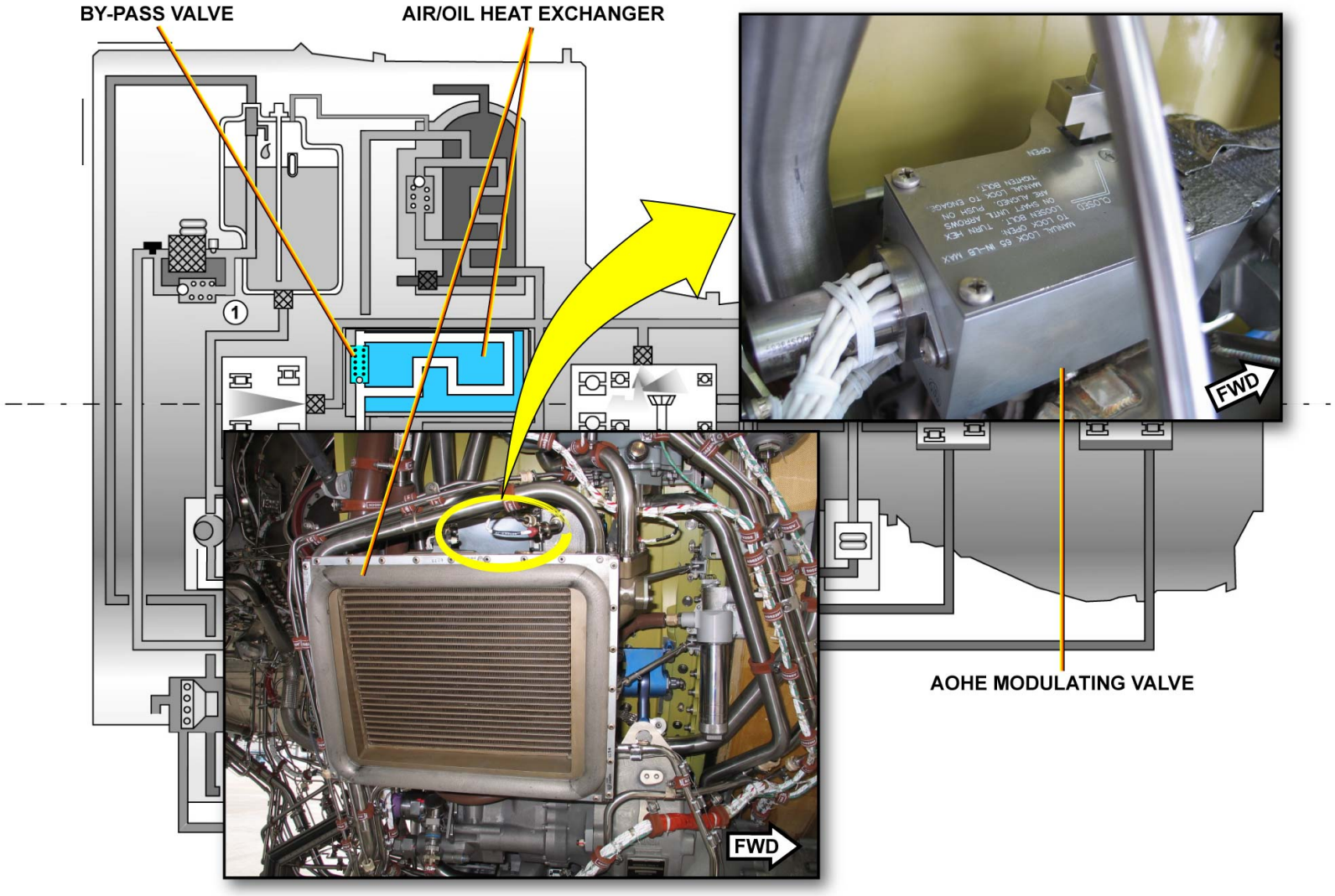

DESCRIPTION - AIR OIL HEAT EXCHANGER (AOHE)

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

FUEL OIL HEAT EXCHANGER (FOHE)

The Fuel Oil Heat Exchanger (FOHE) is installed on the upper right hand side of the fan case above the oil tank. The FOHE is divided into two main parts:
- a heat exchanger assembly,
- a fuel filter housing assembly.

The heat exchanger assembly has a core with fuel tubes attached to baffle and end plates. The oil cools as it flows around the tubes and plates. A bypass valve makes sure that the core is protected in case of oil abnormal pressure. There is an oil drain plug at the bottom of the core for servicing purposes.

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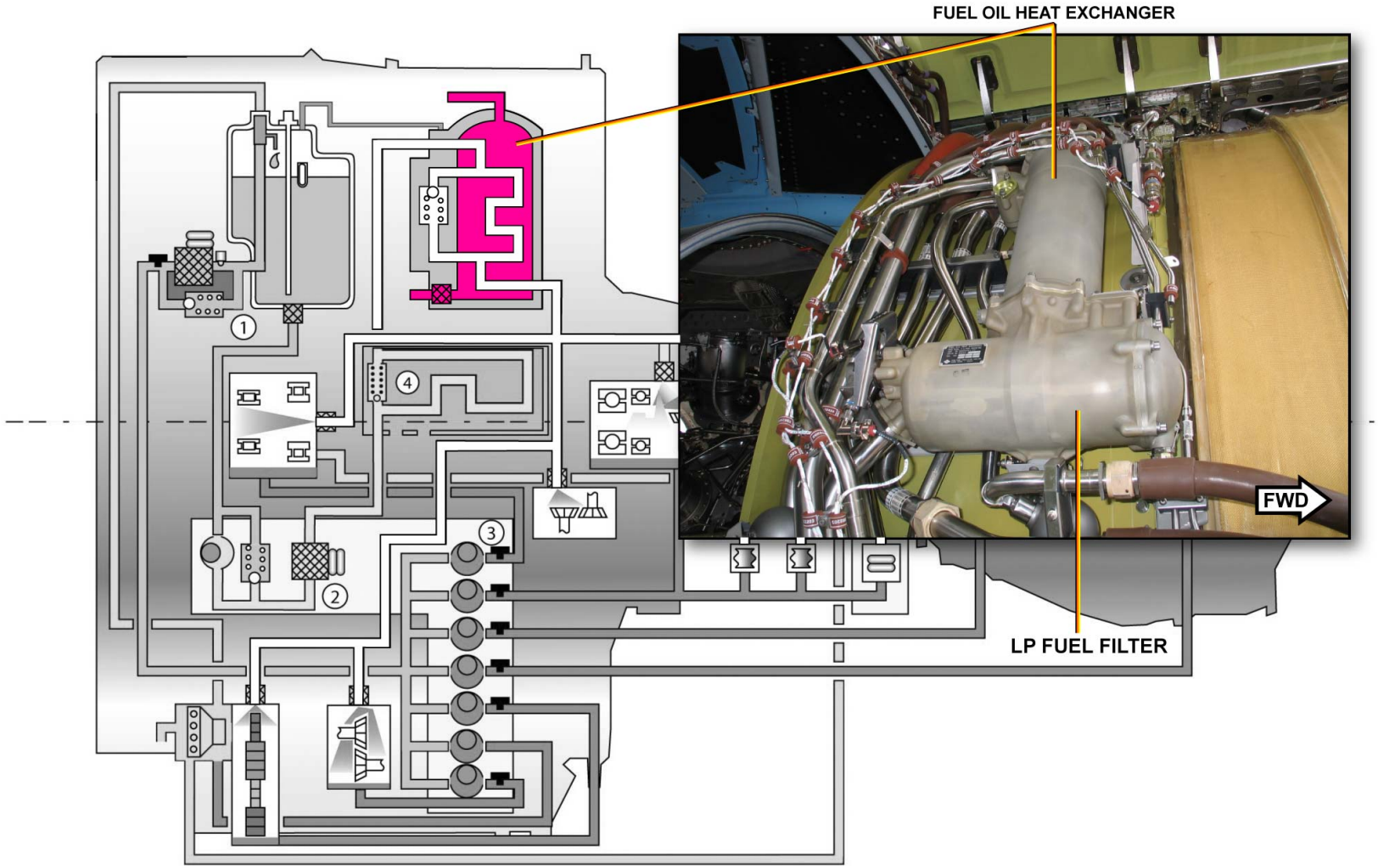


DESCRIPTION - FUEL OIL HEAT EXCHANGER (FOHE)

GCL13151 - G6RT1DU - FM70D7000000071

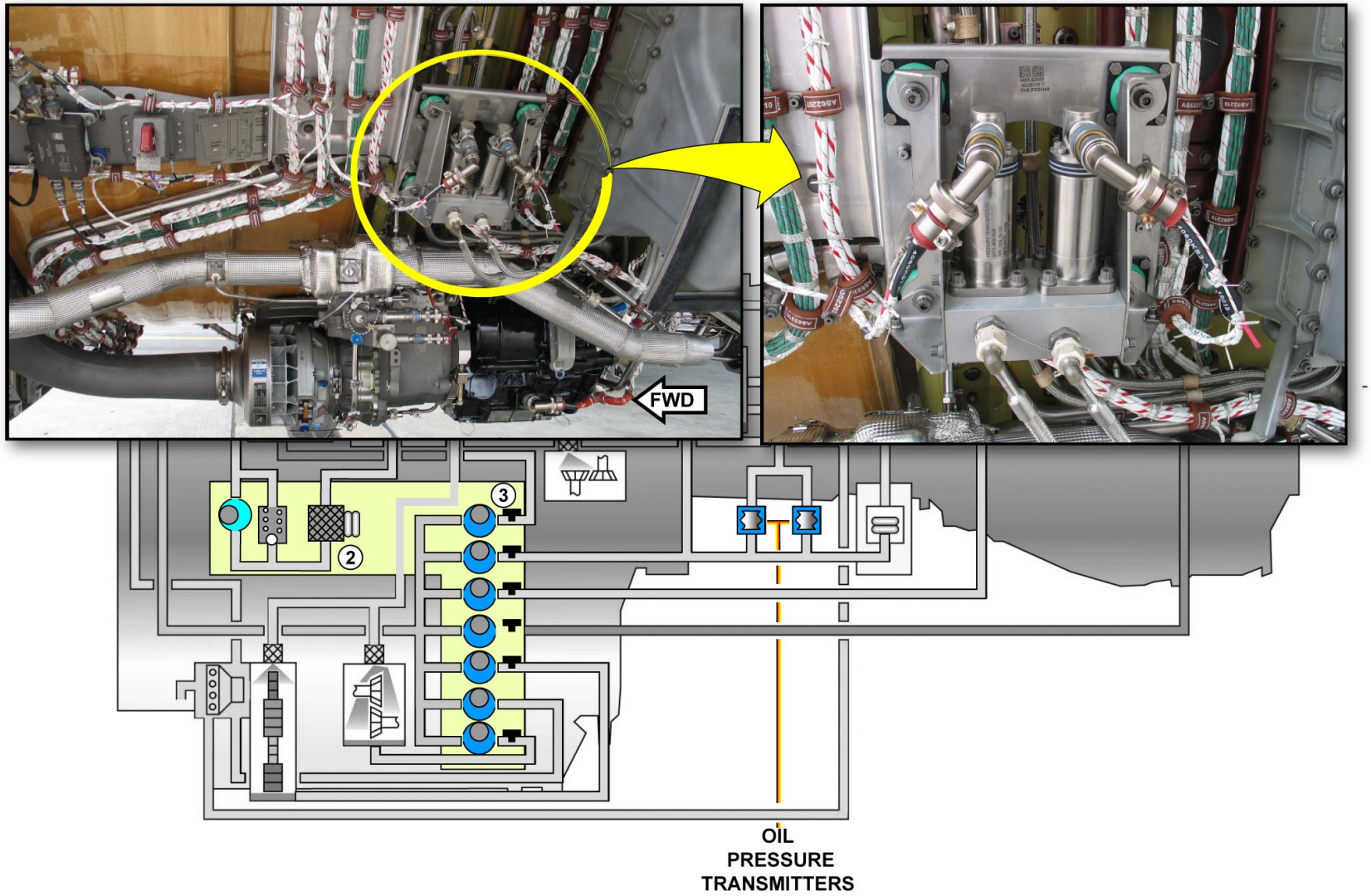
OIL SYSTEM D/O (3)

DESCRIPTION (continued)

PRESSURE TRANSMITTERS

Two oil pressure transmitters are located on the engine LH side the fan case. Each transmitter is electrically connected to an EEC channel. The difference of the two oil pressures will cause a voltage output signal.

GCL13151 - G6RT1DU - FM70D7000000071



DESCRIPTION - PRESSURE TRANSMITTERS

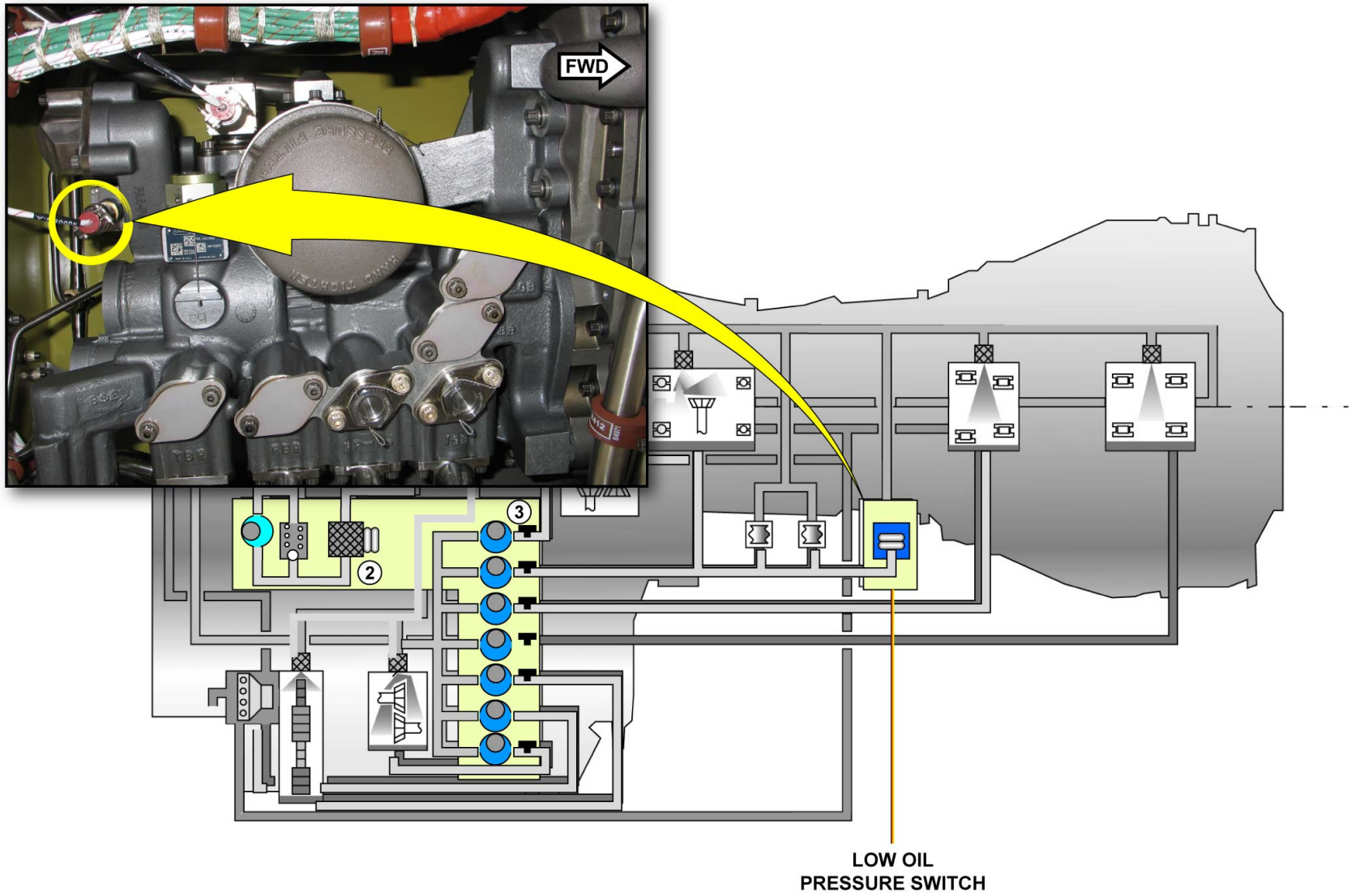
OIL SYSTEM D/O (3)

DESCRIPTION (continued)

LOW OIL PRESSURE SWITCH

The switch compares the main oil pressure and the scavenge oil pressure.
The switch gives an indication directly to the cockpit if the difference in oil pressures becomes too low.

GCL13151 - G6RT1DU - FM70D7000000071



DESCRIPTION - LOW OIL PRESSURE SWITCH

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

MAGNETIC CHIP DETECTORS

A magnetic chip detector is installed on each of the 6 return lines to the scavenge pumps. Each chip detector has a magnetic tip to collect particles and a thread for installation into its housing. The housing is designed for the installation of a strainer. When it is installed, the chip detector is safe with a lockwire. The detectors are used for damage location determination after electrical chip detector detection.

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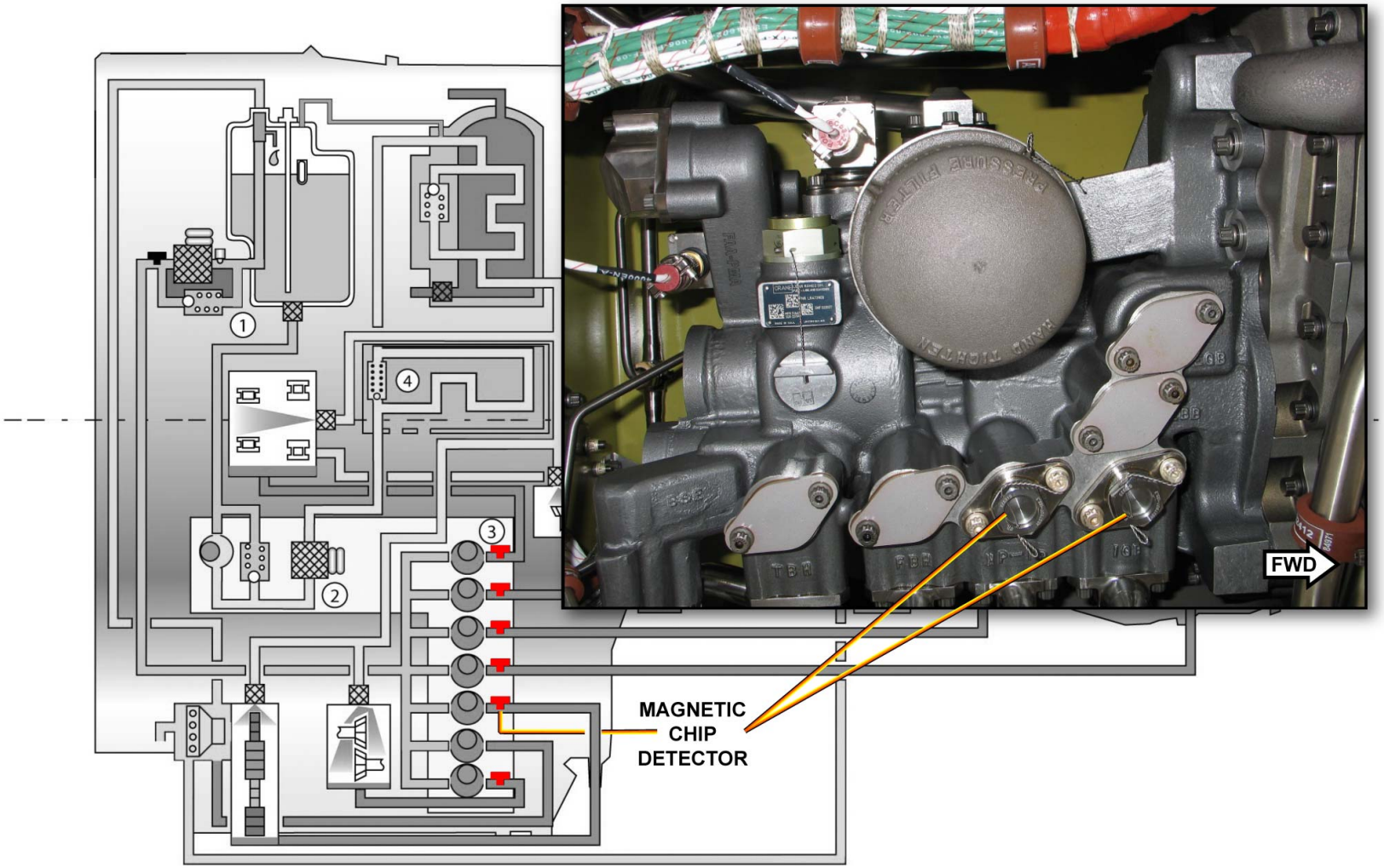

DESCRIPTION - MAGNETIC CHIP DETECTORS

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

MASTER MAGNETIC CHIP DETECTOR

An Master Magnetic Chip Detector (MMCD) is installed downstream of the scavenge pumps, in the scavenge filter assembly.

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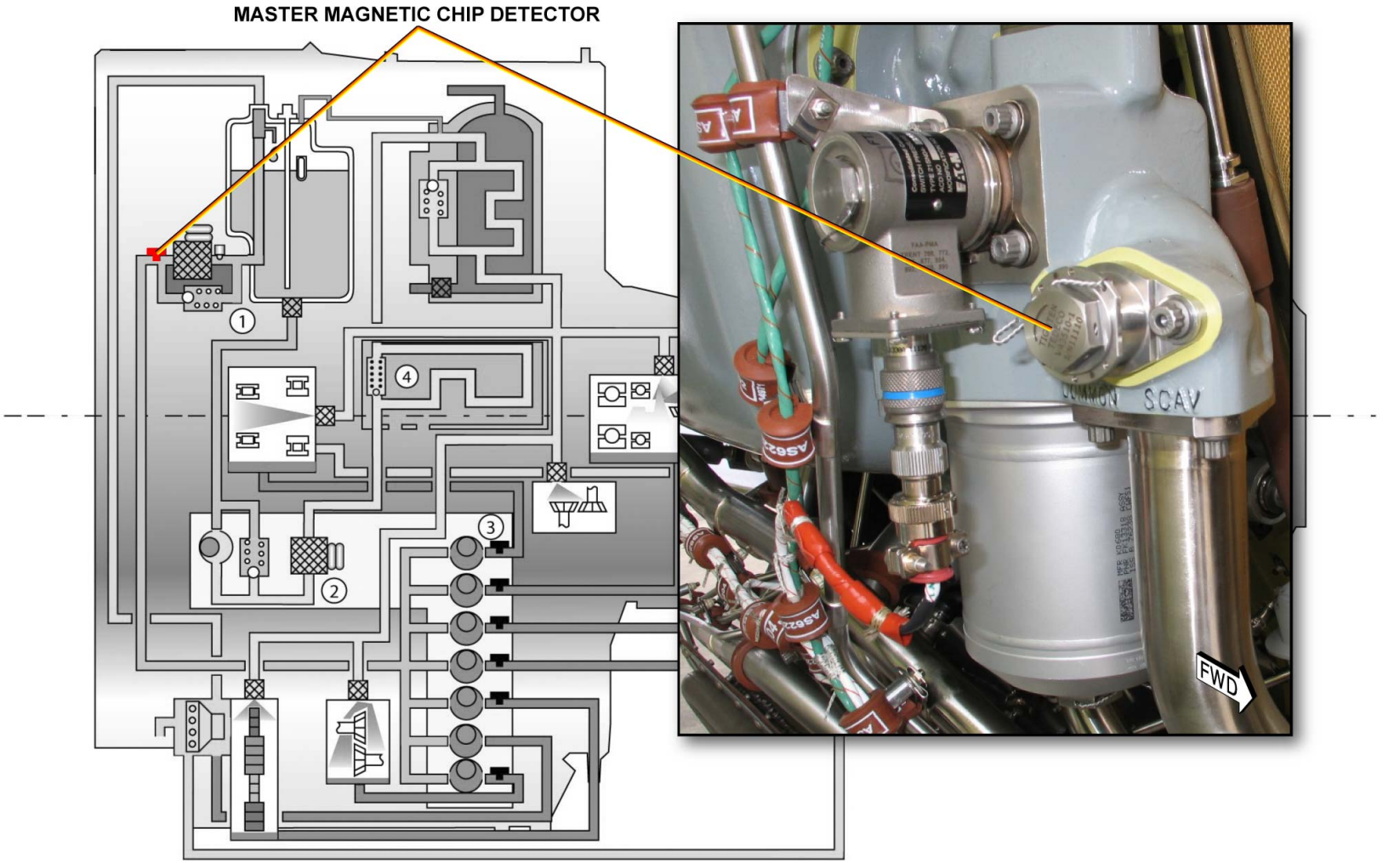

DESCRIPTION - MASTER MAGNETIC CHIP DETECTOR

OIL SYSTEM D/O (3)

DESCRIPTION (continued)

OIL SCAVENGE FILTER ASSEMBLY

The scavenge oil filter assembly is installed on the lower part of the oil tank.
The assembly is composed of:
- a filter housing,
- a filter element,
- a bypass valve.

The filter cover has a bypass valve, which lets the oil flow through to the oil tank if the element becomes clogged. An oil drain plug in the bottom of the housing lets the oil drain when the element has to be replaced. The filter element is not cleanable. A pressure filter differential pressure switch, installed on the filter housing, contains a differential pressure sensitive mechanism, which monitors the filter condition.

OIL TEMPERATURE SENSORS

The two oil temperature sensors are installed between the scavenge filter element and oil tank, on the scavenge filter housing. Each sensor is electrically connected to an EEC channel and has a stainless steel case, which contains a temperature sensitive element.

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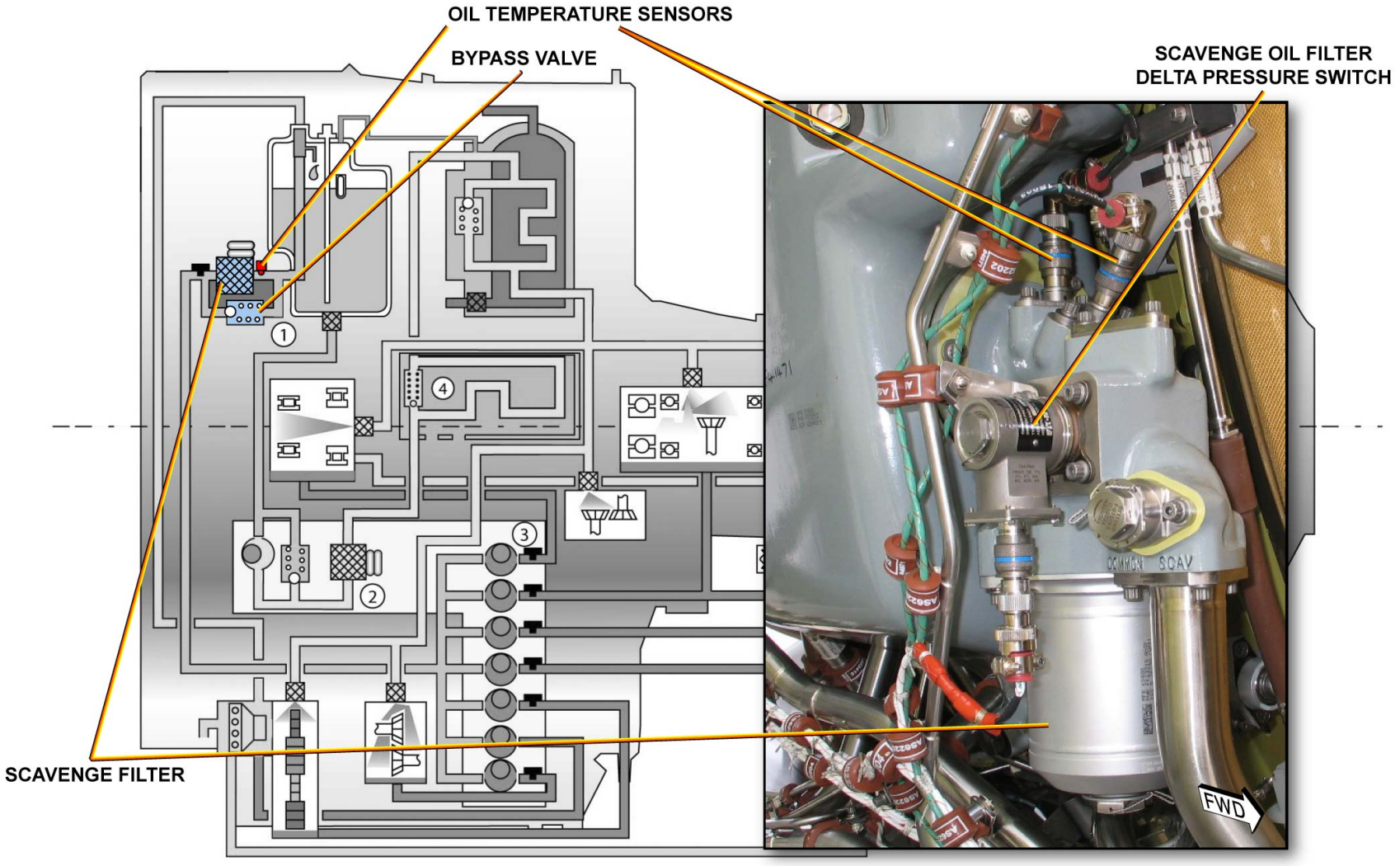

DESCRIPTION - OIL SCAVENGE FILTER ASSEMBLY & OIL TEMPERATURE SENSORS

OIL SYSTEM D/O (3)

OIL SYSTEM OPERATION

The operation of the oil system is divided into three parts:
- storage,
- pressure flow,
- scavenge flow and vent.

PRESSURE FLOW

The oil is drawn from the oil tank through a strainer by suction from the pressure pump as the gearbox starts to turn. The pump assembly also includes a cold-start relief valve, which protects the system by relieving excessive pressure back to the pump inlet. The pressure pump increases the pressure and supplies oil through the pressure filter to the Air Oil Heat Exchanger (AOHE).
The AOHE is made up of a heat exchanger and an air modulating valve. In certain operating conditions, the AOHE uses LP air to decrease the oil temperature. From the AOHE, oil flows to the Fuel Oil heat Exchanger (FOHE). The FOHE has two functions. The primary function is to decrease the oil temperature and the secondary function is to increase the temperature of the fuel to prevent icing. Both heat exchangers have cold start relief valves, which will bypass the exchangers when the oil pressure is excessive.
For lubrication and cooling purposes, the oil flows from the FOHE to the different users:
- front bearing chamber,
- LP/Intermediate Pressure (IP)/High Pressure (HP) location bearing chamber and internal gearbox,
- HP/IP turbine bearing chamber,
- LP turbine bearing chamber,
- intermediate gearbox assembly,
- gearbox input drive,
- external gearbox and centrifugal breather.

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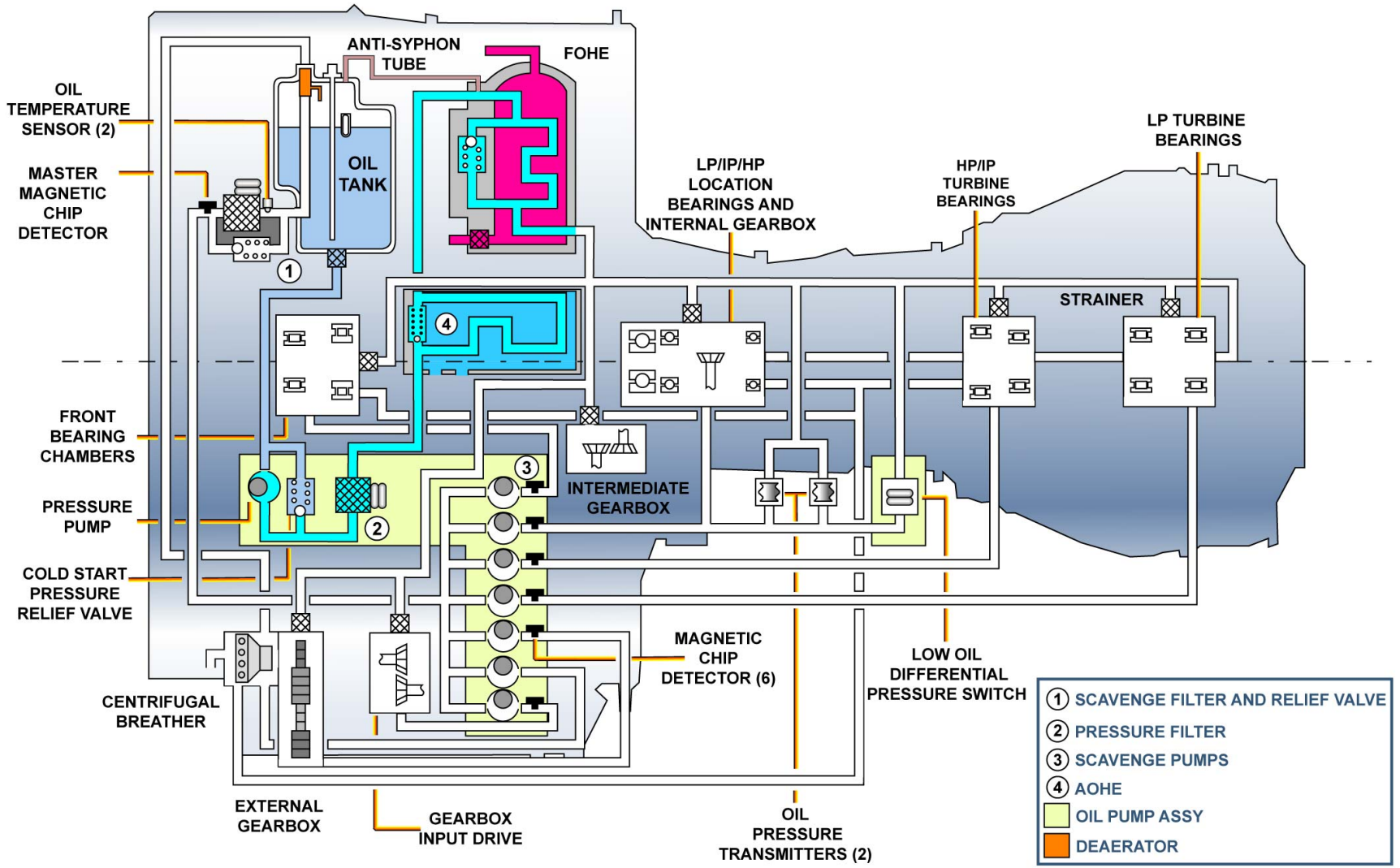
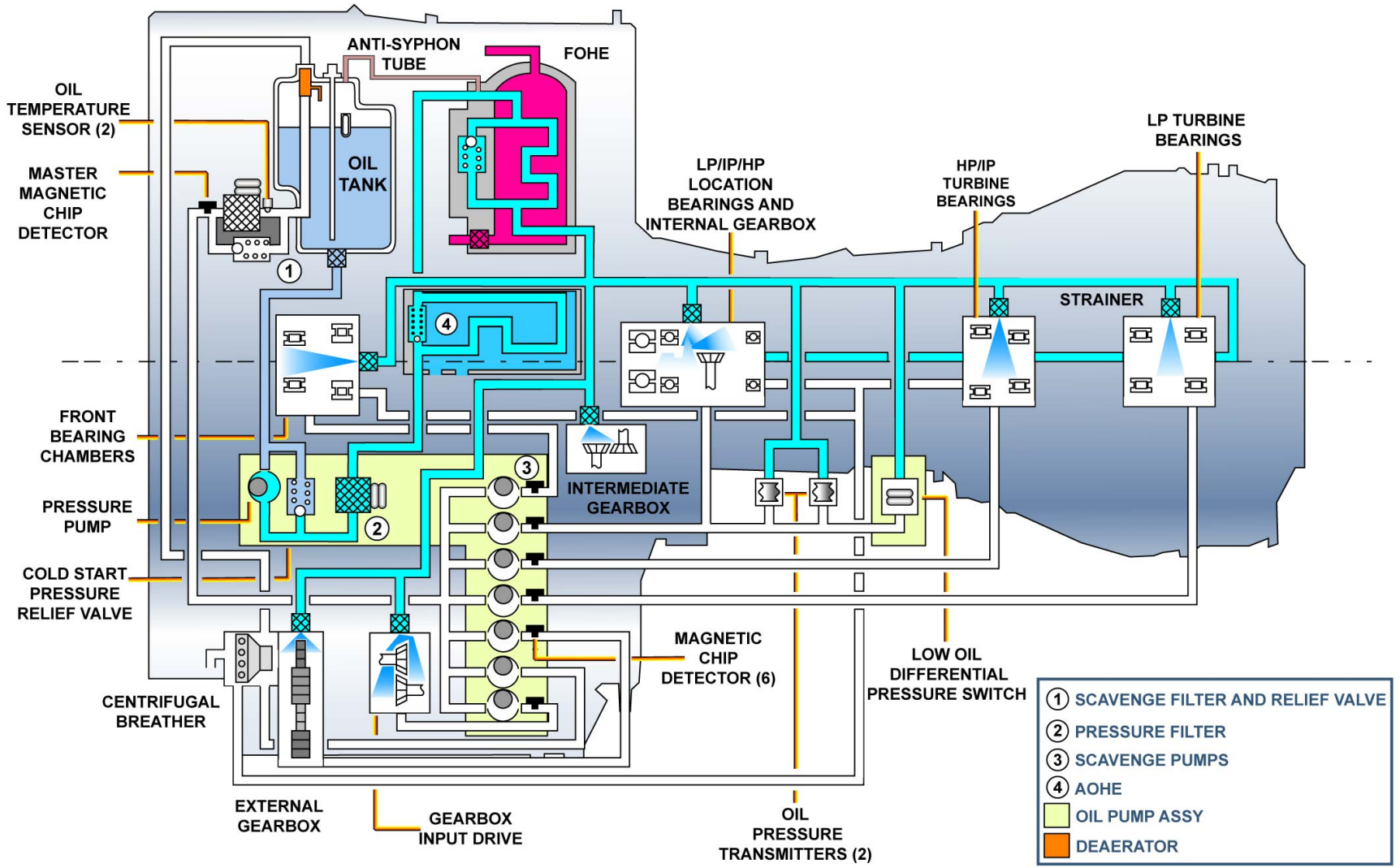


OIL SYSTEM OPERATION - PRESSURE FLOW

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM OPERATION - PRESSURE FLOW

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OIL SYSTEM D/O (3)

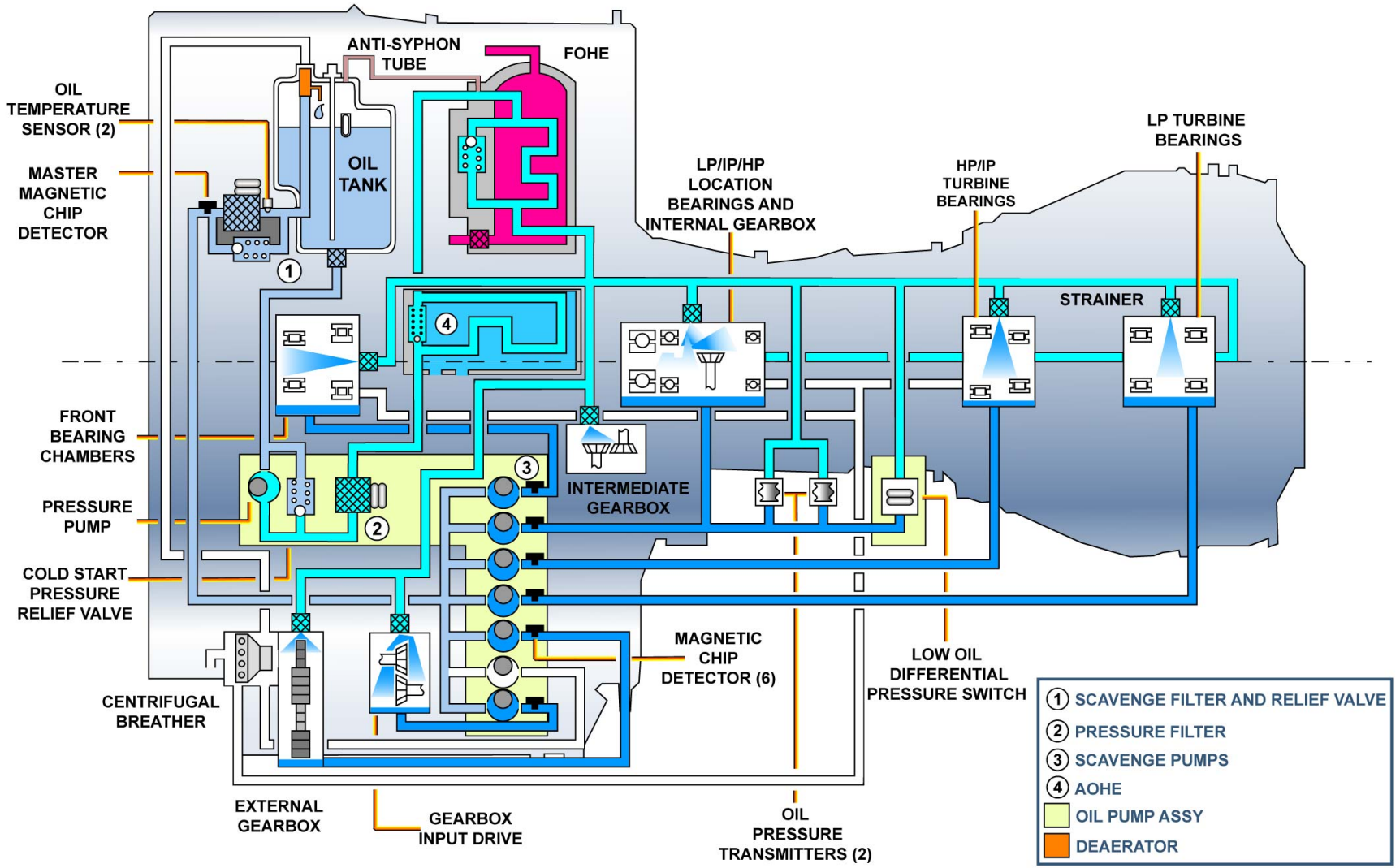
OIL SYSTEM OPERATION (continued)

SCAVENGE FLOW

From the breather and the lubricated bearing locations (except intermediate gearbox), the oil is returned to the tank by seven scavenge pump elements. The oil scavenge pump outlets connect together in a combined scavenge return flow to the scavenge filter through the master magnetic chip detector. The scavenge filter cleans the oil returning to the oil tank. As the oil goes into the tank it flows over a deaerator. The scavenge oil contains (pressurizing) air due to normal leakage across the bearing compartment seals. The deaerator separates any air from the scavenge oil. The separated air is discharged overboard through the centrifugal breather driven by the gearbox.

NOTE: Six magnetic chip detectors can be installed upstream of the pumps to sample return oil and detect any contamination (optional installation).

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM OPERATION - SCAVENGE FLOW

GCL13151 - G6RT1DU - FM70D7000000071

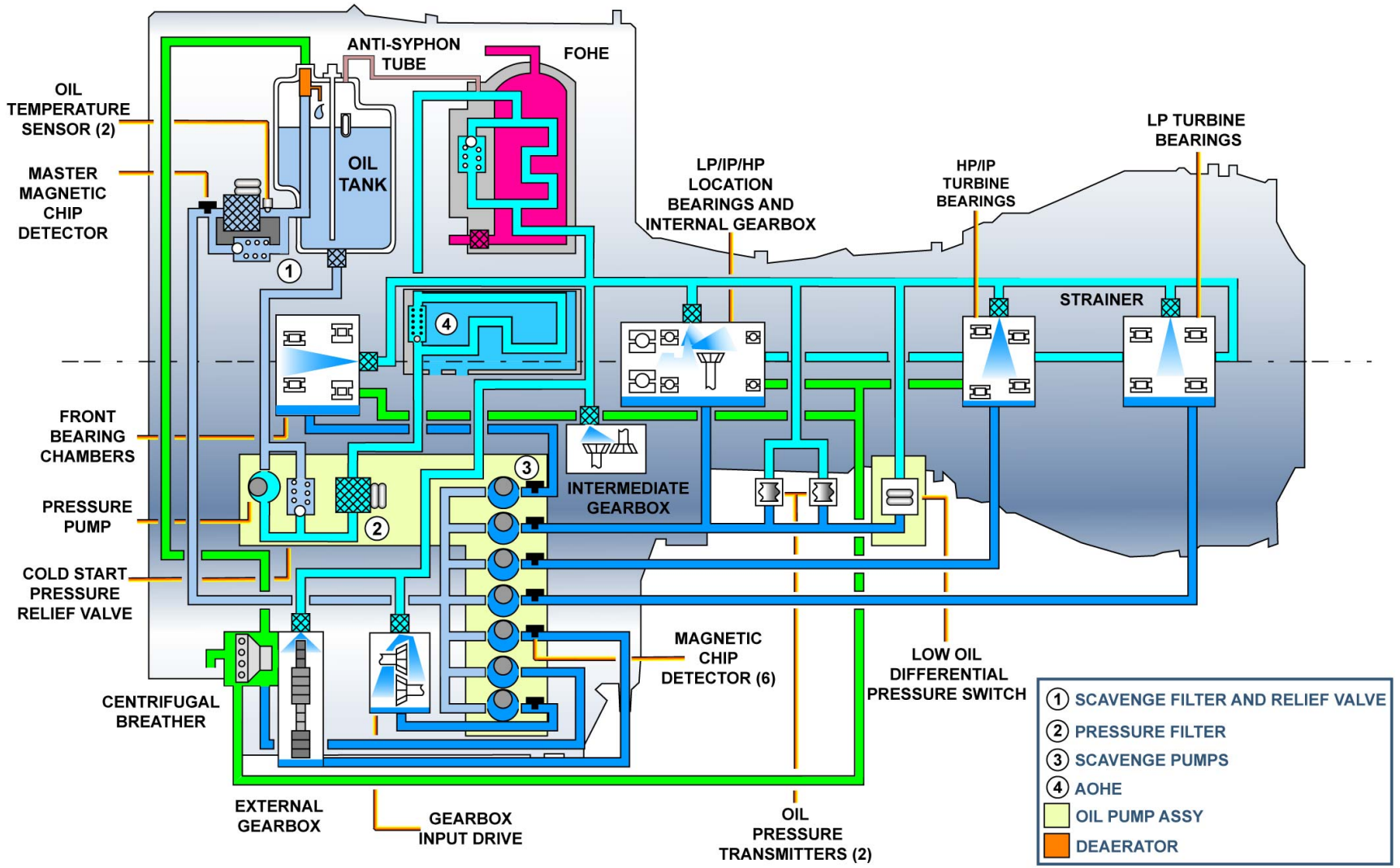
OIL SYSTEM D/O (3)

OIL SYSTEM OPERATION (continued)

OIL VENT SYSTEM

To maintain the pressure drop across the seals in order to prevent oil leakage, the main bearing chambers are vented by external tubes to the centrifugal breather, driven by the gearbox. The LP turbine bearings chamber is vented by means of an internal center tube (through the LP shaft) to the HP/IP turbine bearing chamber. The engine centrifugal breather extracts the venting air/oil mixture and separates the oil from the air before directing the air overboard through the breather outlet. The breather also makes sure that any oil droplets remaining in the air from the oil tank de-aerator are separated before discharging. Any oil separated is scavenged from the breather housing back to the oil tank.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM OPERATION - OIL VENT SYSTEM

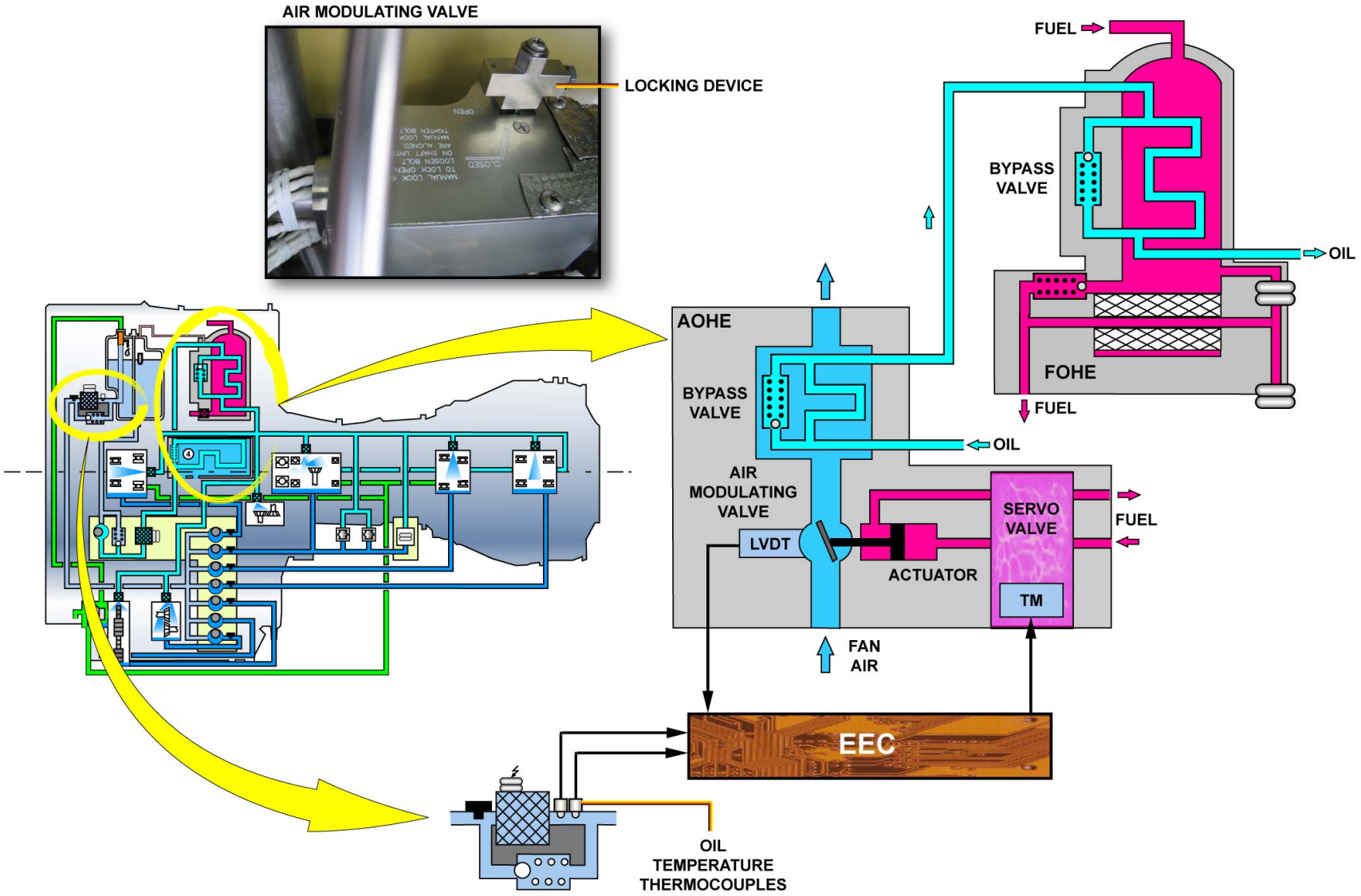
GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

ENGINE OIL HEAT MANAGEMENT

The AOHE, together with the FOHE, keeps the oil temperature within the specified limits to give the best engine performance. When the FOHE is not able to maintain the oil temperature within the limits (due to low fuel flow through the FOHE at idle operation, for example), fan air is supplied to the AOHE by means of an air modulating valve controlled by the Engine Electronic Controller (EEC). This air modulating valve is actuated by a hydraulic actuator which uses fuel through a servo valve as servo pressure. The EEC uses the oil temperature as the primary control parameter and the Linear Variable Differential Transducer (LVDT) signals as feedback for the AOHE servo valve Torque Motor (TM) control. When the oil temperature is within nominal limits, the EEC sends a signal to the servo valve TM to close the air modulating valve.
In case of failure, the AOHE modulating valve can be deactivated in the open position by means of its locking device located on its upper face.

GCL13151 - G6RT1DU - FM70D7000000071



ENGINE OIL HEAT MANAGEMENT

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

OIL SYSTEM MONITORING

The following oil system parameters are monitored.

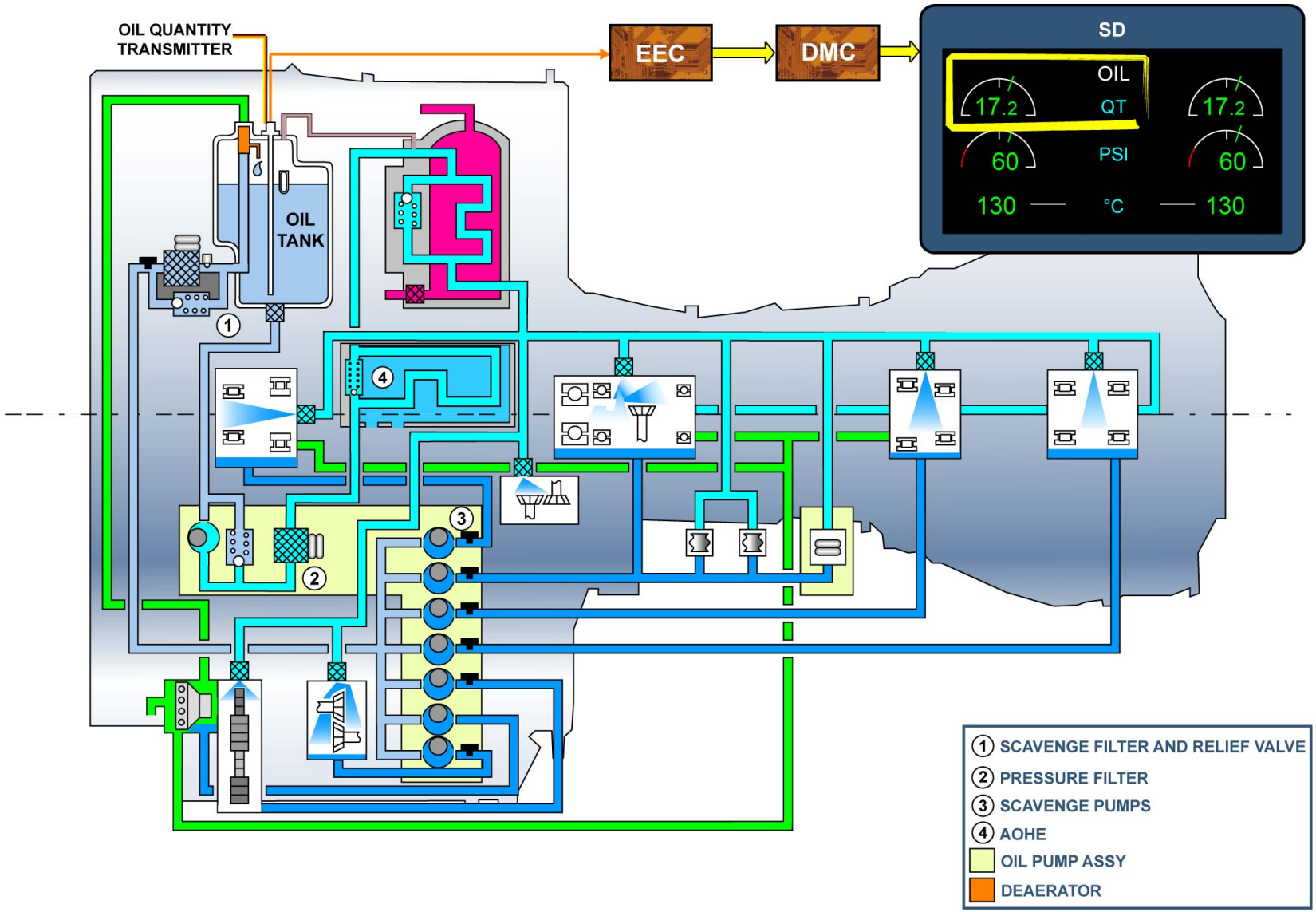
OIL LEVEL

A sight glass installed in the side of the tank gives a visual indication of the oil level.

OIL QUANTITY

An oil quantity transmitter sends an analog signal to the EEC, which is in proportion to the quantity of engine oil in the tank. This signal is converted into digital format by the EEC, and as a result, an oil quantity indication is displayed on the SD engine page.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - OIL LEVEL & OIL QUANTITY

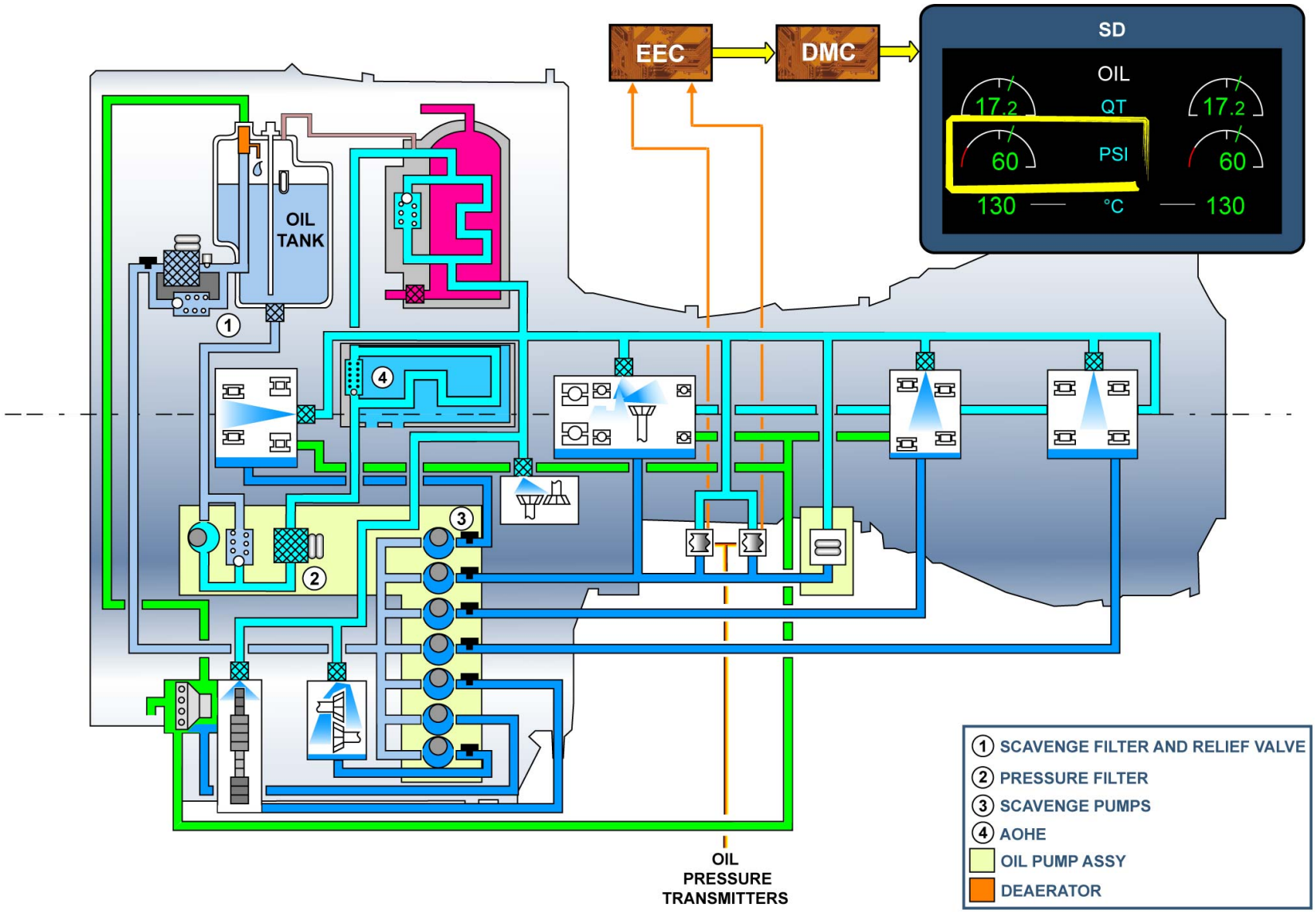
OIL SYSTEM D/O (3)

OIL SYSTEM MONITORING (continued)

OIL PRESSURE

Two pressure transmitters sense the oil pressure between the oil pressure lines and the oil scavenge lines. In proportion to the differential oil pressure, one pressure transmitter sends a signal to EEC channel A and the other sends a signal to EEC channel B. As a result, an oil pressure needle and digital indication are displayed on the System Display (SD) engine page.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - OIL PRESSURE

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

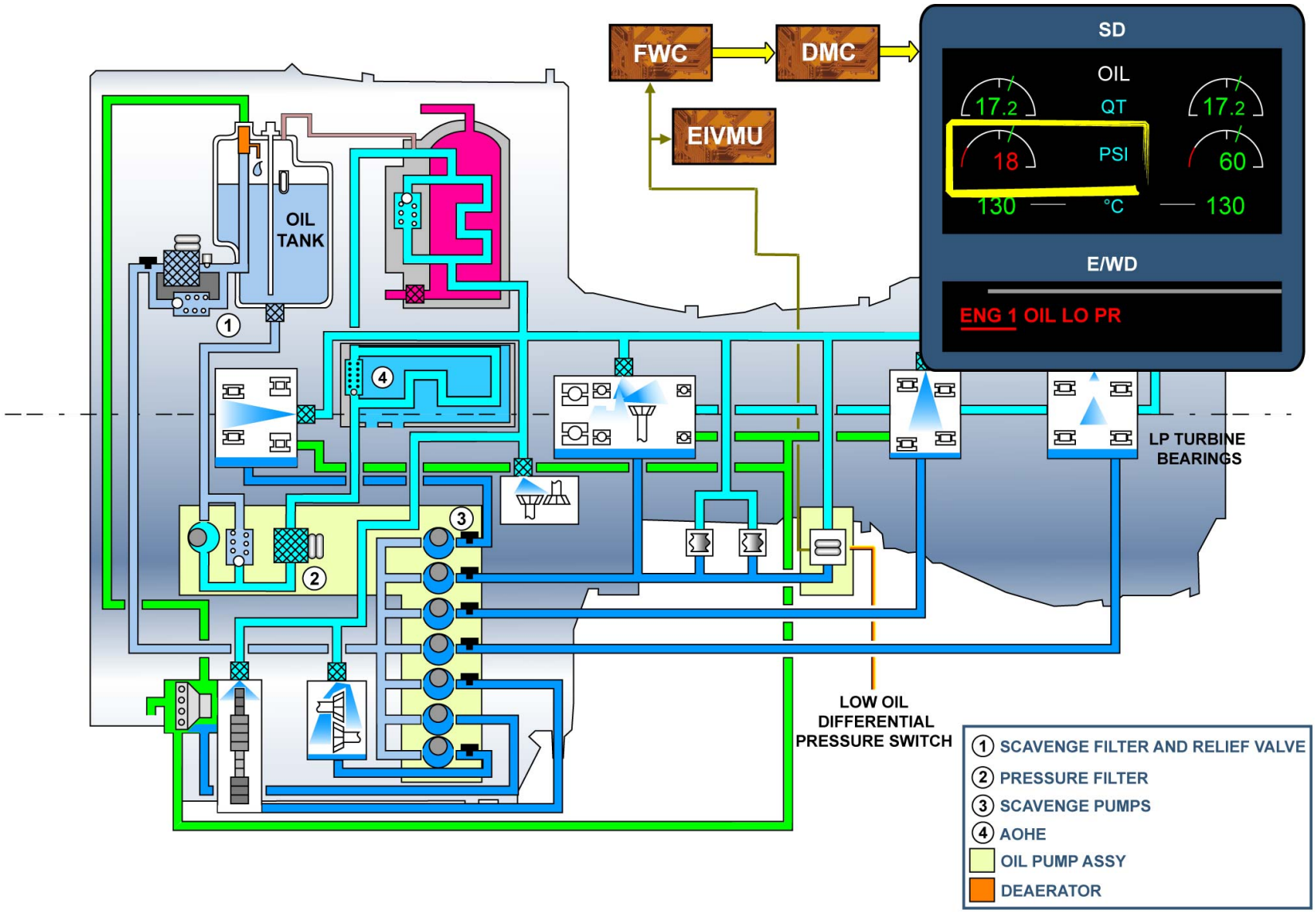
OIL SYSTEM MONITORING (continued)

LOW OIL PRESSURE DETECTION

A low oil differential pressure switch sends a low oil pressure signal to the Engine Interface and Vibration Monitoring Unit (EIVMU), Flight Warning Computers (FWCs) when the pressure drops below 25 psi. As a result:

- the oil pressure needle and digital indications are displayed in red on the SD engine page,
- the MASTER WARNING flashes and the continuous repetitive chime sounds,
- an ENG OIL LO PR warning is displayed on the Engine and Warning Display (E/WD).

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - LOW OIL PRESSURE DETECTION

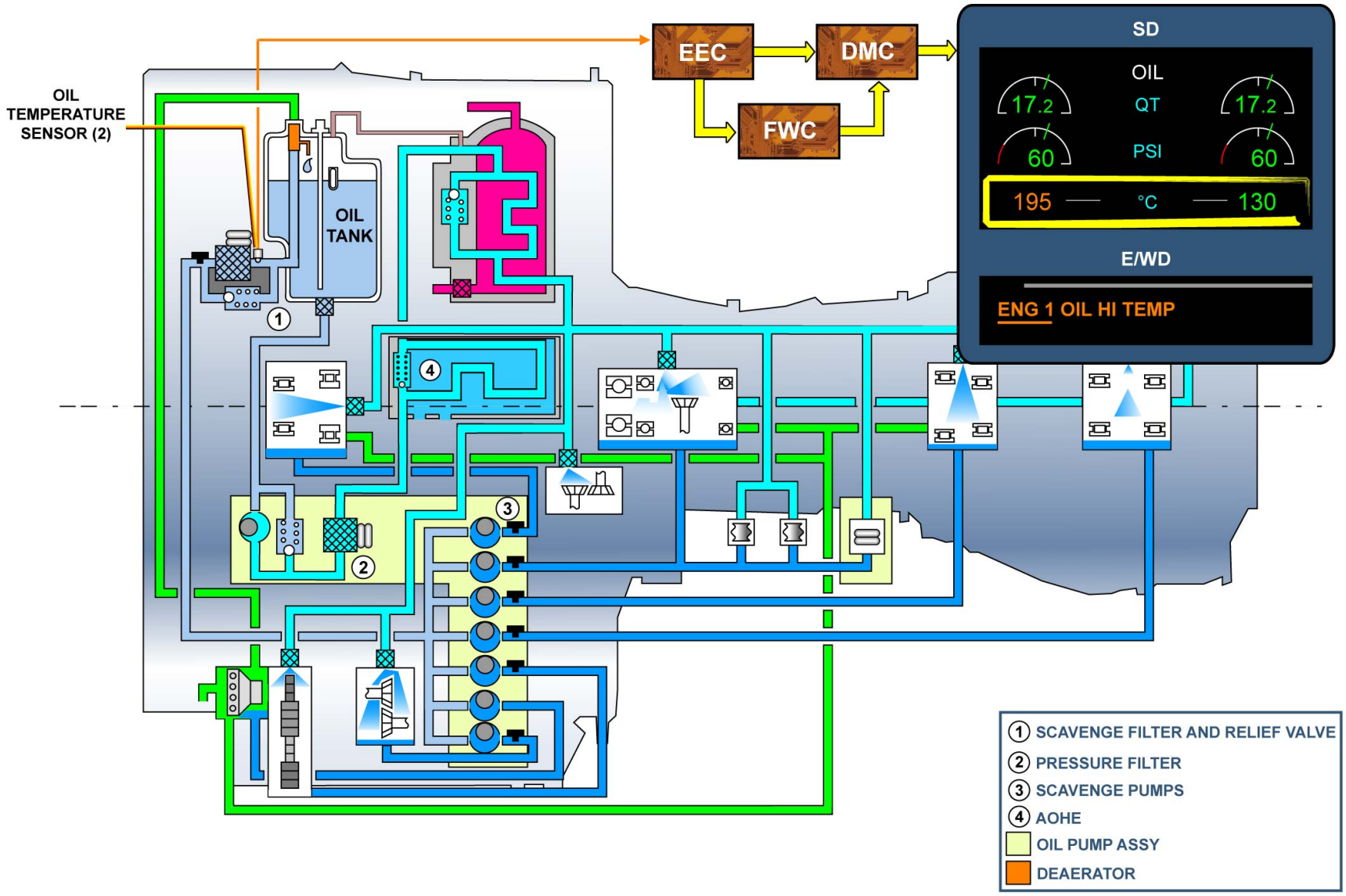
OIL SYSTEM D/O (3)

OIL SYSTEM MONITORING (continued)

OIL TEMPERATURE

Two oil temperature thermocouples send analog signals to the EEC. These signals are converted into digital format by the EEC, and as a result, an oil temperature indication is displayed on the SD engine page. If the oil temperature exceeds 190° Celsius, or is lower than 20° Celsius with the engine running on ground:
- the ENG OIL HI TEMP or ENG OIL LO TEMP warning is triggered on the E/WD,
- the MASTER CAUTION comes on and the single chime also sounds.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - OIL TEMPERATURE

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

OIL SYSTEM MONITORING (continued)

FILTER CLOG

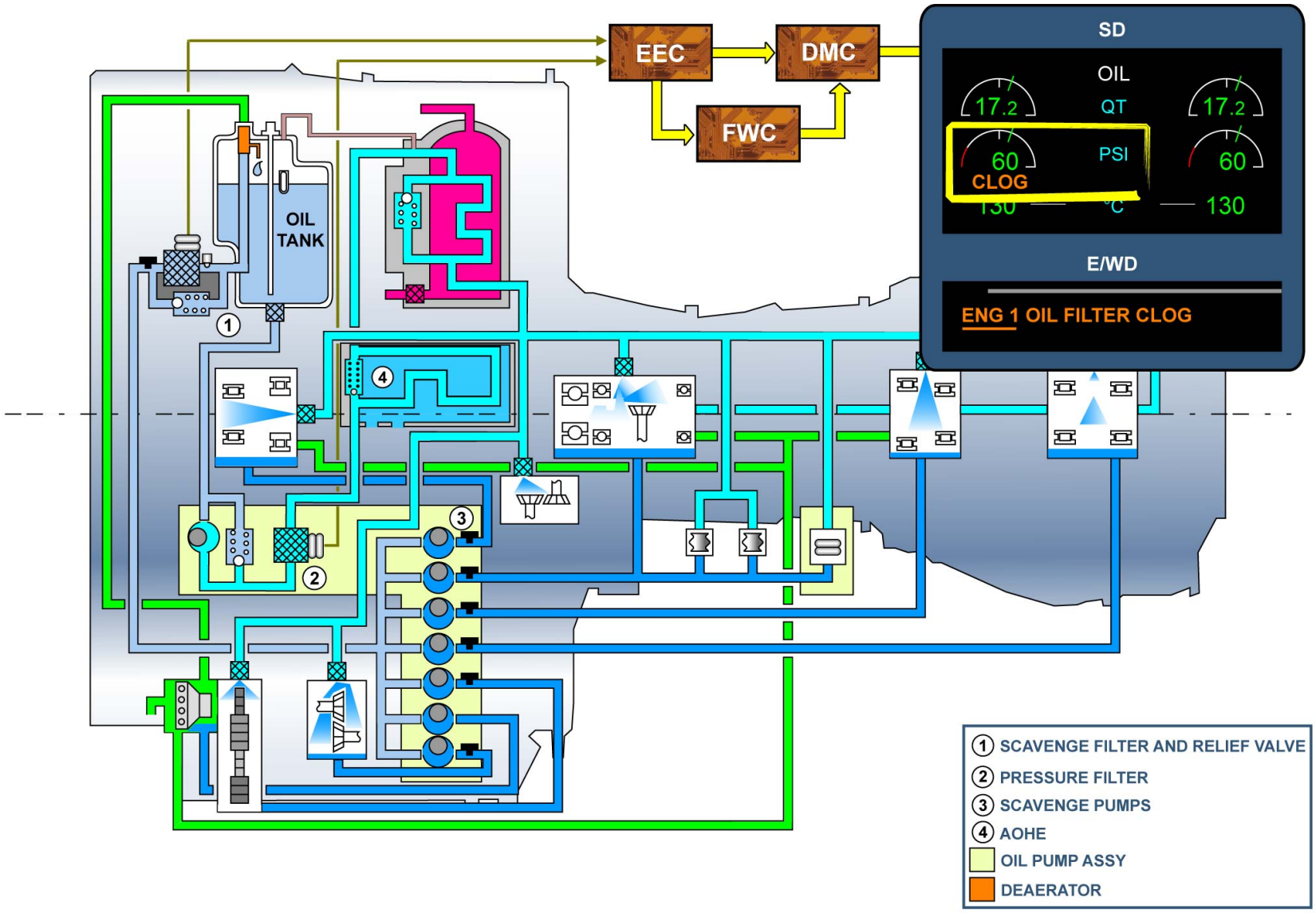
A pressure filter differential pressure switch and a scavenge filter differential pressure switch send discrete signals to the EEC if the differential pressure across the scavenge oil filter or the pressure oil filter exceeds maximum values. As a result:
- a CLOG indication is displayed on the SD engine page,
- the MASTER CAUTION comes on and the single chime sounds,
- an ENG OIL FILTER CLOG warning is displayed on the E/WD.

NOTE: Note: in the case of an OIL FILTER CLOG warning, the Post Flight Report (PFR) will indicate which filter is clogged (either high pressure or scavenge filter) in a clearly-worded message.

MASTER CHIP DETECTOR

The master magnetic chip detector, when removed and examined, gives an indication of the general condition of the lubricated internal engine components. If metal particles are found on this master magnetic chip detector, a magnetic chip detector must then be installed on each of the 6 return lines for isolation and subsequent analysis.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - FILTER CLOG & MASTER CHIP DETECTOR

GCL13151 - G6RT1DU - FM70D7000000071

OIL SYSTEM D/O (3)

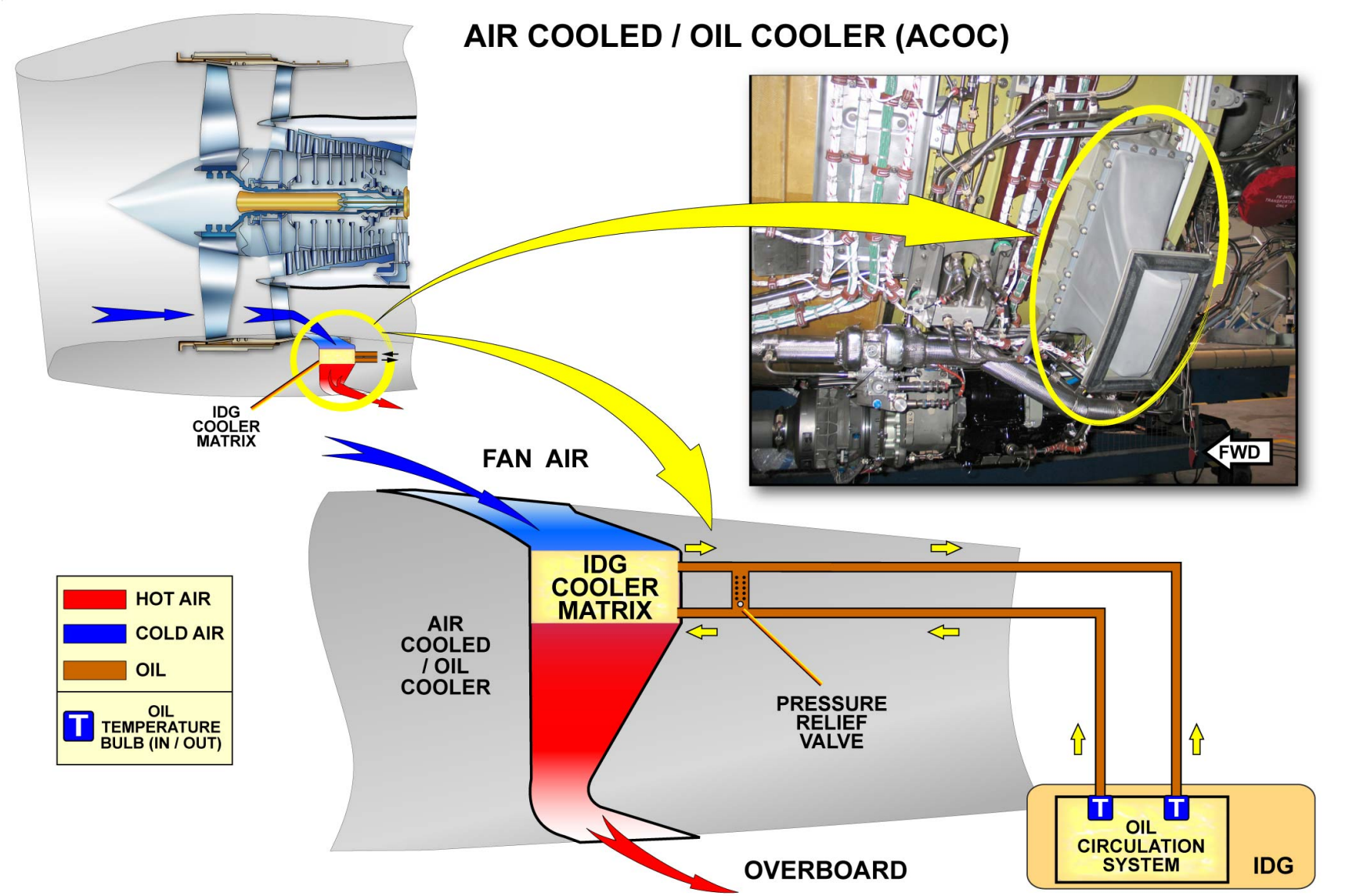
OIL SYSTEM MONITORING (continued)

IDG OIL SERVICING

The Integrated Drive Generator (I.D.G.) is the primary source of AC electrical power supply to the aircraft. Each engine has an I.D.G. mounted on the left hand side rear face of the external gearbox. An oil system, which is an integral part of the I.D.G., lubricates the I.D.G. bearings and keeps it cool. The system is connected to an external Air Cooled Oil Cooler (A.C.O.C.) to keep the oil temperature at a satisfactory level.

The A.C.O.C is a simple air oil heat exchanger, mounted on the lower L.H side of the L.P. compressor case. Hot oil from the I.D.G flows through the matrix, where it is cooled by L.P. compressor air, before returning to the I.D.G There is a pressure relief valve (by-pass) between the oil inlet and outlet connections. If the oil is cold it will not flow easily through the matrix therefore the valve will open and the oil bypasses the A.C.O.C.

GCL13151 - G6RT1DU - FM70D7000000071



OIL SYSTEM MONITORING - IDG OIL SERVICING

ENGINE SYSTEM OPERATION, CONTROL & INDICATING (3)

ENG 1 EPR MODE FAULT

ENG 1 EIU FAULT

ENG 1 OIL & ENG 2 FUEL FILTER CLOG

ANIMATED SCHEMATIC

GCL13151 - G6RT1DU - FM70IZLEVEL0301

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GCL13151 - G6RT1DU - FM70IZLEVEL0301

POWER PLANT SYSTEM LINE MAINTENANCE (2)

SERVICING

ENGINE OIL SERVICING

The procedure is as follows:
- pull FADEC C/Bs,
- open the oil servicing access panel on the RH fan cowl door,

NOTE: Make sure that the engine has been shut down for at least 10 minutes before checking the engine oil level.

- check the oil level in the oil tank sight glass.

NOTE: Note: If the oil level is low and the engine has been stopped for more than 6 hours, start the engine. Run the engine at idle for 5 minutes. Shut down the engine, wait 10 minutes and check the oil level again.

The gravity fill procedure is as follows:
- remove the oil filler cap from the oil tank and add oil until the oil reaches the correct level on the sight glass.

The pressure fill procedure is as follows:
- connect a drain hose to the overflow coupling on the oil tank,
- connect the pressure hose to the pressure coupling,
- add oil until the oil reaches the correct level on the sight glass,
- a small quantity of oil will drain from the overflow hose when the oil is at the proper level.

GCL13151 - G6RT1DU - FM70B1000000071

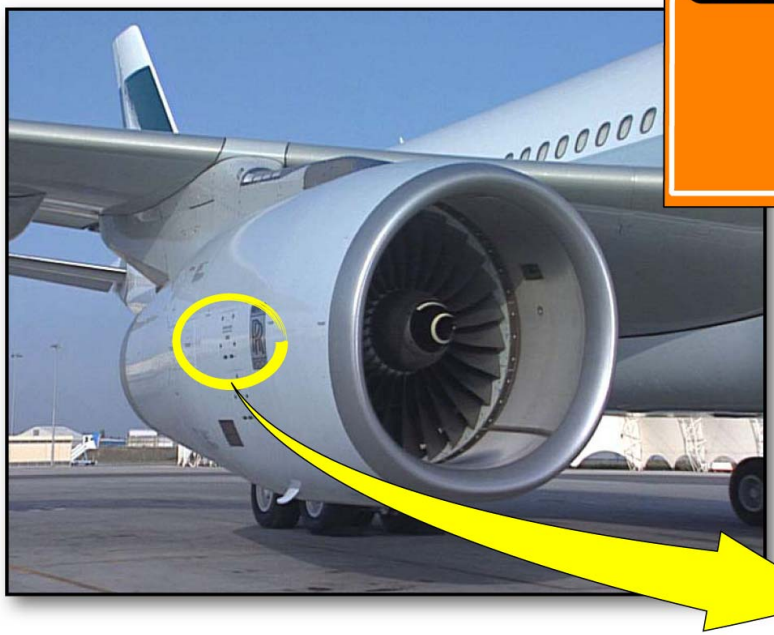
✓ ENGINE OIL SERVICING.

CAUTION

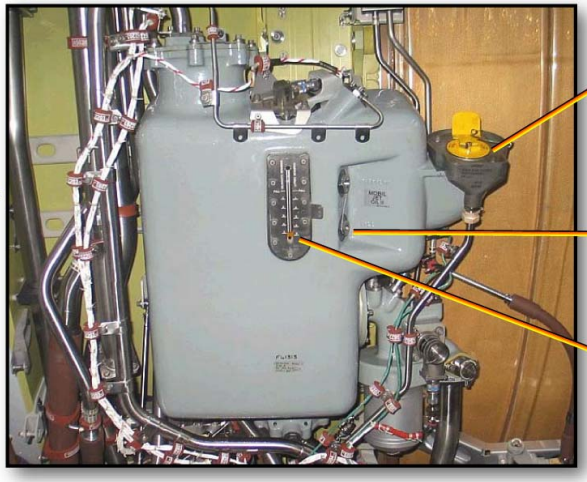
YOU MUST WAIT A MINIMUM OF 10 MINUTES AFTER THE ENGINE HAS STOPPED BEFORE YOU CHECK THE ENGINE OIL LEVEL.

IF THE OIL LEVEL IS LOW AND THE ENGINE HAS BEEN STOPPED FOR MORE THAN 6 HOURS, START THE ENGINE:
- RUN THE ENGINE AT IDLE FOR 5 MINUTES,
- SHUT DOWN THE ENGINE, WAIT 10 MINUTES AND CHECK THE OIL LEVEL AGAIN.

OIL SERVICING ACCESS DOORS



OIL TANK



SERVICING - ENGINE OIL SERVICING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

SERVICING (continued)

OPENING AND CLOSING OF THE FAN COWL DOORS

The procedure is as follows:
- release the deflection restraint on the fan cowl door,
- release the cowl latches (See AMM for the proper sequence),

WARNING: Be careful when opening the fan cowl door. Each door weighs 138 lbs. (63 kg.)
- open the cowls to get access to the hold-open rods,
- connect both hold-open rods,
- open the cowls to the middle or fully extended position on the hold-open rods,

WARNING: To prevent accidental closure and possible injury, make sure that the hold-open rods are attached correctly and locked in position.
- close fan cowl doors in the opposite sequence.

WARNING: Do not open the fan cowl doors when the wind speed is more than 60 mph (96 km/h).
Open the fan cowl doors with caution when the wind speed is more than 30 mph (48 km/h).
Do not run the engine above idle power when the fan cowl doors are open and secured with the hold-open rods.

WARNING: To prevent accidental closure and possible injury, make sure that the hold-open rods are attached correctly and locked in position.

GCL13151 - G6RT1DU - FM70B1000000071

FAN COWL LATCHES

HOLD OPEN RODS

SERVICING - OPENING AND CLOSING OF THE FAN COWL DOORS

SERVICING - OPENING AND CLOSING OF THE FAN COWL DOORS

SERVICING - OPENING AND CLOSING OF THE FAN COWL DOORS

POWER PLANT SYSTEM LINE MAINTENANCE (2)

SERVICING (continued)

OPENING AND CLOSING OF THE THRUST REVERSER DOORS

The procedure is as follows:
- open the fan cowl doors,
- put the thrust reverser Isolation Control Unit (ICU) in the deactivated position,
- open the latch access and pressure relief doors at the bottom of the nacelle,

WARNING: Make sure that the take-up device of the thrust reverser half is engaged before you release the latches. If not, the latches can open quickly and cause injury or damage.

- install and operate the take-up device to take the load off the latches before opening. The take-up device is stowed on a bracket inside the reverser cowl,
- release the hook latches (Check AMM for proper sequence),
- use a 3/8" square drive to release the 2 pin latches,
- disengage the take-up device,
- connect the pump pressure hose to the opening actuator manifold quick disconnect,
- pump to open the door,
- install the FRONT and REAR hold-open rods.

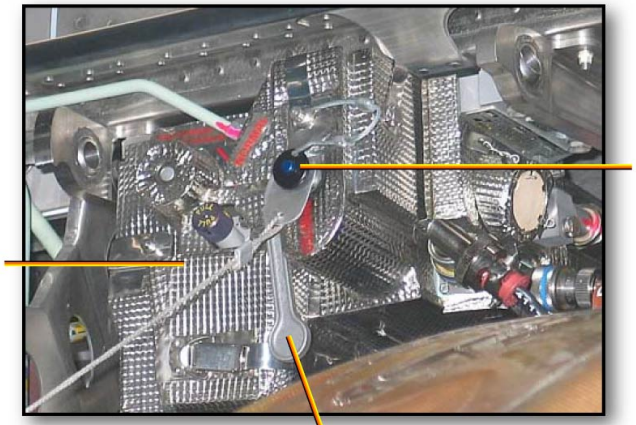
To close:
- pump to open the door and to take the pressure off the hold-open rods,
- disconnect the FRONT and REAR hold-open rods,
- open the pump relief valve and let the doors close slowly,
- when the doors are fully closed, use the take-up device to pull the two halves together,
- secure the pin latches then disconnect the take-up device and stow it,
- secure the rest of the latches and close the access panel.

WARNING: Do not open the thrust reverser when the wind speed is 46 mph (73 km/h) or more. An injury and/or damage may occur if the wind moves the thrust reverser.

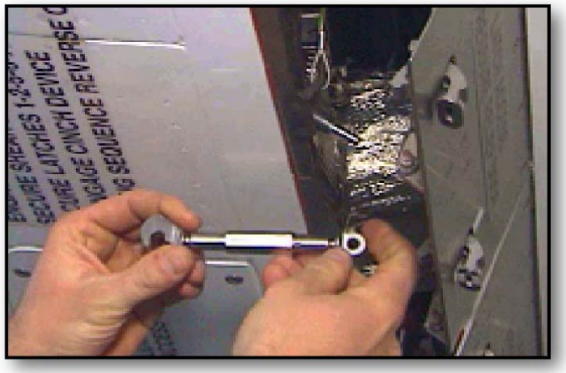
WARNING: Make sure that the take-up device of the thrust reverser half is engaged before you release the latches. If not, the latches can open quickly and cause injury or damage.

GCL13151 - G6RT1DU - FM70B1000000071

1 Deactivate the thrust reverser ICU.



THRUST REVERSER LATCH ACCESS



TAKE-UP DEVICE

TAKE-UP DEVICE STOWAGE

SERVICING - OPENING AND CLOSING OF THE THRUST REVERSER DOORS

SERVICING - OPENING AND CLOSING OF THE THRUST REVERSER DOORS

SERVICING - OPENING AND CLOSING OF THE THRUST REVERSER DOORS

POWER PLANT SYSTEM LINE MAINTENANCE (2)

DAILY CHECKS

INLET AND EXHAUST INSPECTION

A visual inspection of the engine inlet and exhaust should be carried out prior to any engine run.

NOTE: Note: Refer to the AMM (ATA 72) for damage limits.
Inlet Inspection - Check the following areas for damage:
- inlet leading edge,
- inner acoustic liner,
- LP compressor (fan) blades, including each blade leading and trailing edge,
- annulus fillers.

Exhaust Inspection - Check the following areas for damage:
- check stage 4 LP turbine blades for damage/cracks.

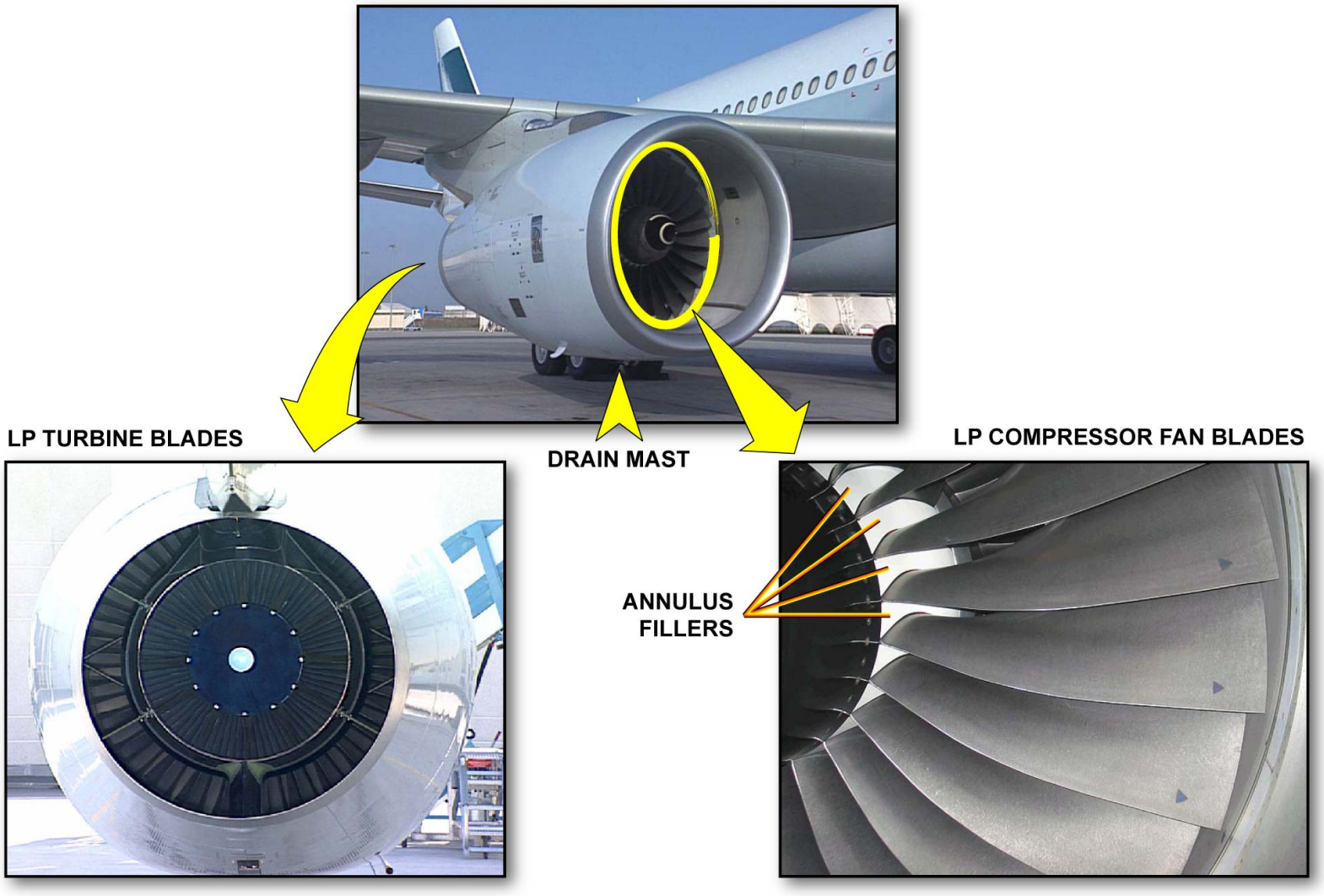
NOTE: Note: Very few damage are bearable on the turbine blades. Any cracked blade causes engine removal.

INSPECT ENGINE DRAINS FOR LEAKS

The engine drain mast and pylon drains are designed to isolate fluid leaks from the different areas of the engine to get easier troubleshooting. Any leaks should be investigated. Leakage limits are based on engine running or stopped. Depending on the found leak, dispatch may be permitted.

NOTE: Note: Refer to the AMM (ATA 71) for leakage limits.

GCL13151 - G6RT1DU - FM70B1000000071



DAILY CHECKS - INLET AND EXHAUST INSPECTION & INSPECT ENGINE DRAINS FOR LEAKS

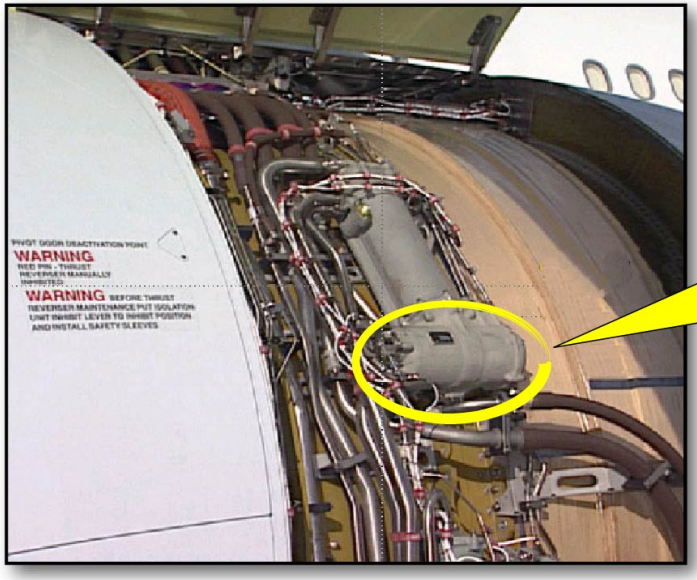
POWER PLANT SYSTEM LINE MAINTENANCE (2)

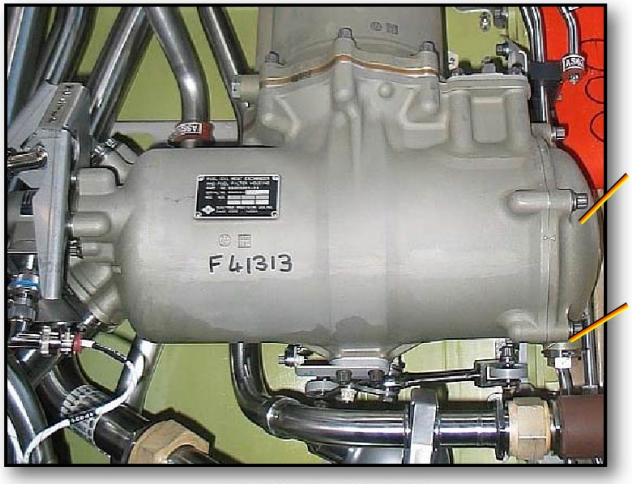
MEL/DEACTIVATION

FUEL FILTER CLOG

The aircraft may be dispatched as per the Minimum Equipment List (MEL), with the FUEL CLOG warning inoperative. The conditions for dispatch show that the fuel filter has to be replaced daily or every 15 flight hours (whichever comes first).
The procedure is as follows:
- pull the FADEC Circuit Breakers (C/Bs),
- pull LP and HP fuel shut off valve C/Bs,
- open the right hand side fan cowl door,
- drain the residual fuel from the fuel oil heat exchanger,
- remove the filter cap and filter element,
- discard old element and replace with new,
- install the filter cap and torque to the correct value.

GCL13151 - G6RT1DU - FM70B1000000071





LP FUEL FILTER

A330/A340 MASTER MINIMUM EQUIPMENT LIST	MMEL ITEMS 73 - ENGINE FUEL AND CONTROL 73-09 - ECAM Alerts
73-09-02	ENG 1(2) FUEL FILTER CLOG Alert

Ident.: MI-73-09-00007642.0002001 / 22 MAR 10
Applicable to: MSN 0713-1331

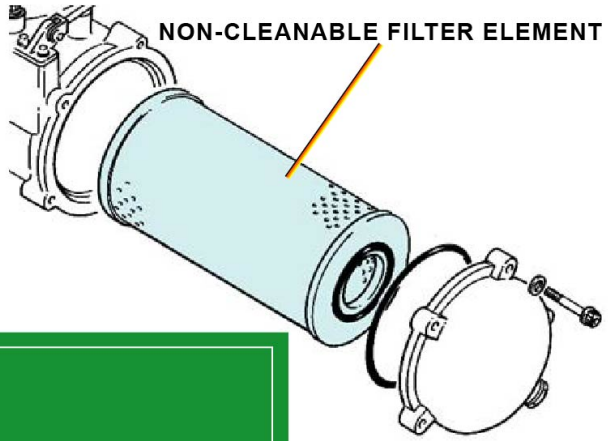
73-09-02A

Repair interval	Nbr installed	Nbr required	Placard
C	2	1	No

(m) One may be inoperative provided that the associated filter is replaced every day or every 15 flight hours, whichever occurs first.

Reference(s)

(m) *Refer to AMM task*



MEL/DEACTIVATION - FUEL FILTER CLOG

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

DEACTIVATE THRUST REVERSER FOR FLIGHT

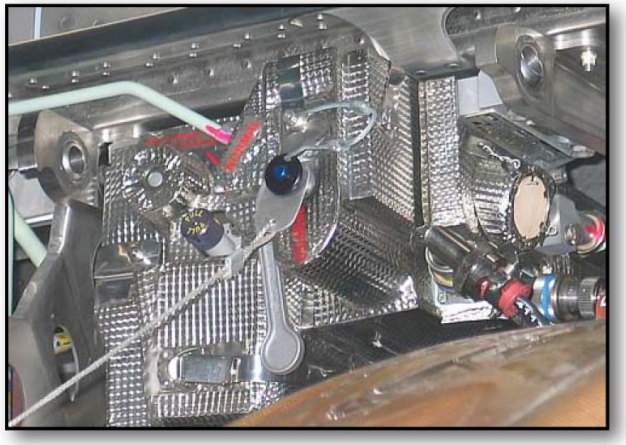
One or both thrust reversers may be deactivated for dispatch, as per the MEL. The reversers must be deactivated in the stowed and locked position. The procedure is as follows:
- pull FADEC C/Bs,
- pull the T/R Locking C/B (tertiary locks),
- open the fan cowl doors,
- deactivate the thrust reverser ICU,

NOTE: Note: Each pivoting door must be secured to the structure.
- remove the inhibition bolt attachment covers from each pivoting door,
- remove the inhibition bolts from their stowage brackets on the leading edge of the reverser assembly,
- install the inhibition bolts in each pivoting door and secure with the locking plates,
- install the plain covers on the stowage brackets,
- on the ECAM E/WD, make sure that the ENG1 (2) REV INHIBITED message is shown.

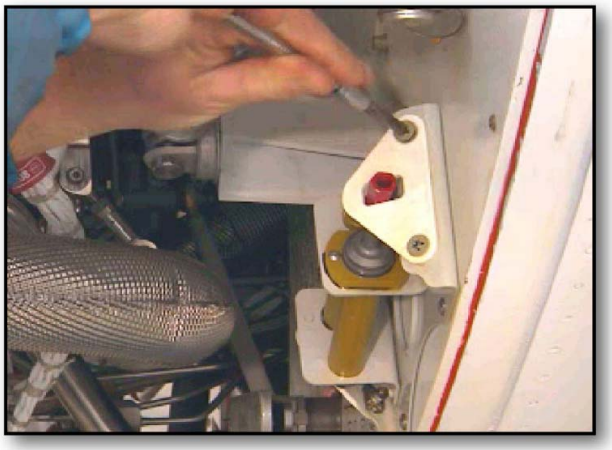
The film shows the procedure of the thrust reverser deactivation.

GCL13151 - G6RT1DU - FM70B1000000071

1 Deactivate the thrust reverser ICU.



2 Remove the inhibition bolt.



3 Install the inhibition bolt.

MEL/DEACTIVATION - DEACTIVATE THRUST REVERSER FOR FLIGHT

MEL/DEACTIVATION - DEACTIVATE THRUST REVERSER FOR FLIGHT

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GCL13151 - G6RT1DU - FM70B1000000071

POWER PLANT SYSTEM LINE MAINTENANCE (2)

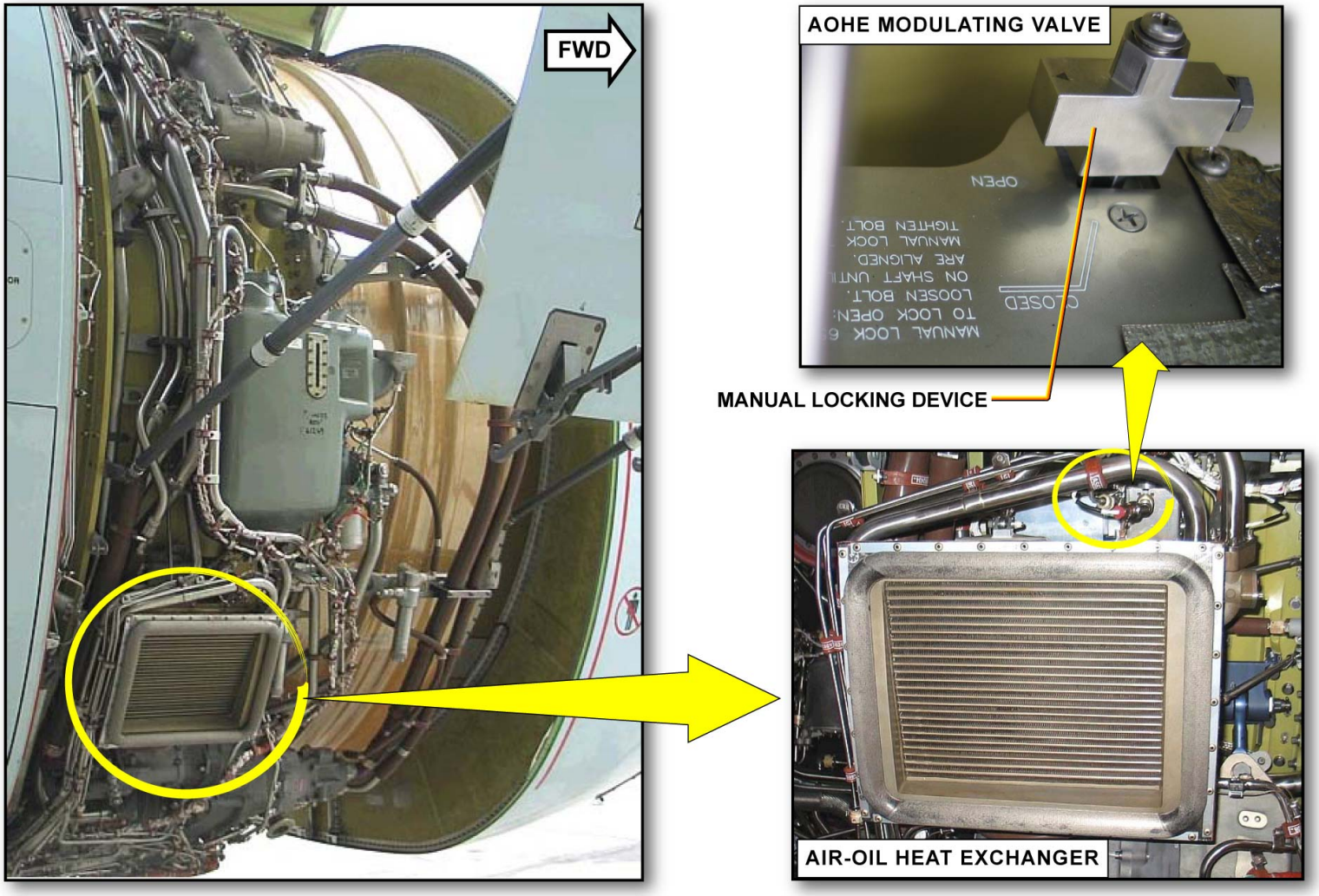
MEL/DEACTIVATION (continued)

AIR OIL HEATER EXCHANGER MODULATING VALVE

In case of a failure of the Air Oil Heat Exchanger (AOHE) modulating valve, the aircraft may be dispatched, as per the MEL with the valve secured in the open position. This will insure sufficient oil cooling.
The procedure is as follows:
- pull the FADEC C/Bs,
- open the RH fan cowl door,
- make sure that the valve is in the open position and lock it open by one action on the sliding de-activation device.

NOTE: Note: Two different types of valves may be installed based on service bulletins.

GCL13151 - G6RT1DU - FM70B1000000071



MEL/DEACTIVATION - AIR OIL HEATER EXCHANGER MODULATING VALVE

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

OIL QUANTITY INDICATION

In case of a failure of the oil quantity indication, the aircraft may be dispatched, as per the MEL as long as the oil LP switch is operational and there is no evidence of abnormal consumption or leakage. Prior to each flight, the oil quantity must also be checked at the oil tank. The procedure is as follows:

- open fan cowl doors,
- open the thrust reverser cowls,
- do a visual check for oil leakage at the oil equipment, lines and connections,

NOTE: Note: If the oil level is low and the engine has been stopped for more than 6 hours, start the engine. Run the engine at idle for 2 minutes. Shut down the engine, wait 10 minutes and check the oil level again.

- check the oil level in the oil tank and service if necessary,
- on the MCDU, read the EIVMU GROUND REPORT and make sure that there are no messages related to the Oil LP switch,
- close the cowls.

GCL13151 - G6RT1DU - FM70B1000000071

A330/A340 MASTER MINIMUM EQUIPMENT LIST	MMEL ITEMS 79 - OIL 79-07 - Indications on SD pages 79-07-02 - Indications on the ENGINE SD page

79-07-02-03	Oil Quantity Indication on the ENGINE SD page

Ident.: MI-79-07-02-00007694.0004001 / 22 MAR 10
Applicable to: MSN 0713-1331

79-07-02-03A

Repair interval	Nbr installed	Nbr required	Placard
C	2	1	No

(m) One may be inoperative provided that:
- **1)** The oil quantity is checked before each flight, and
- **2)** There is no evidence of abnormal oil consumption or leakage, and
- **3)** There is no OIL LO PR SW/EEC failure message in the EIVMU ground report.

Reference(s)

(m) *Refer to AMM 79-31-00-040-804*

✓ **Inspect engine for oil leaks.**

MEL/DEACTIVATION - OIL QUANTITY INDICATION

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

OIL FILTER CLOG

In case of a failure of the OIL CLOG warning on the ECAM, the aircraft may be dispatched as per the MEL. There are two conditions for dispatch. First, the oil filter must be changed daily (or every 15 FH - whichever comes first). In addition, the Master Chip Detector (MCD) must be inspected for contamination prior to each flight.
The procedure for the replacement of the oil scavenge filter is as follows:
- open the RH fan cowl door,
- drain the residual oil from the filter housing,
- remove the filter housing,
- remove the filter element from the housing,
- discard element and replace with new.

The procedure for MCD inspection is as follows:
- open MCD access door on the RH fan cowl,
- remove the MCD and inspect the probe for contamination,

NOTE: Note: Refer to the AMM (ATA 79) for types and limits of contamination.

- clean the MCD probe, replace seals and reinstall.

NOTE: Note: Refer to the AMM procedure for correct torque values.

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A330/A340
MASTER MINIMUM EQUIPMENT LIST

MMEL ITEMS
79 - OIL
79-09 - ECAM Alerts

79-09-02	ENG 1(2) OIL FILTER CLOG Alert

Ident.: MI-79-09-00007697.0006001 / 15 SEP 10
Applicable to: MSN 0713-1331

79-09-02D Associated oil filter periodically replaced and master chip detector inspected

Repair interval	Nbr installed	Nbr required	Placard
C	2	1	No

(o) (m) One may be displayed on the EWD provided that:

1) The associated filter is replaced before the first MMEL dispatch and then every day or every 15 flight hours whichever occurs first, and

2) The associated master chip detector is inspected when the filter is replaced and does not reveal the presence of chips.

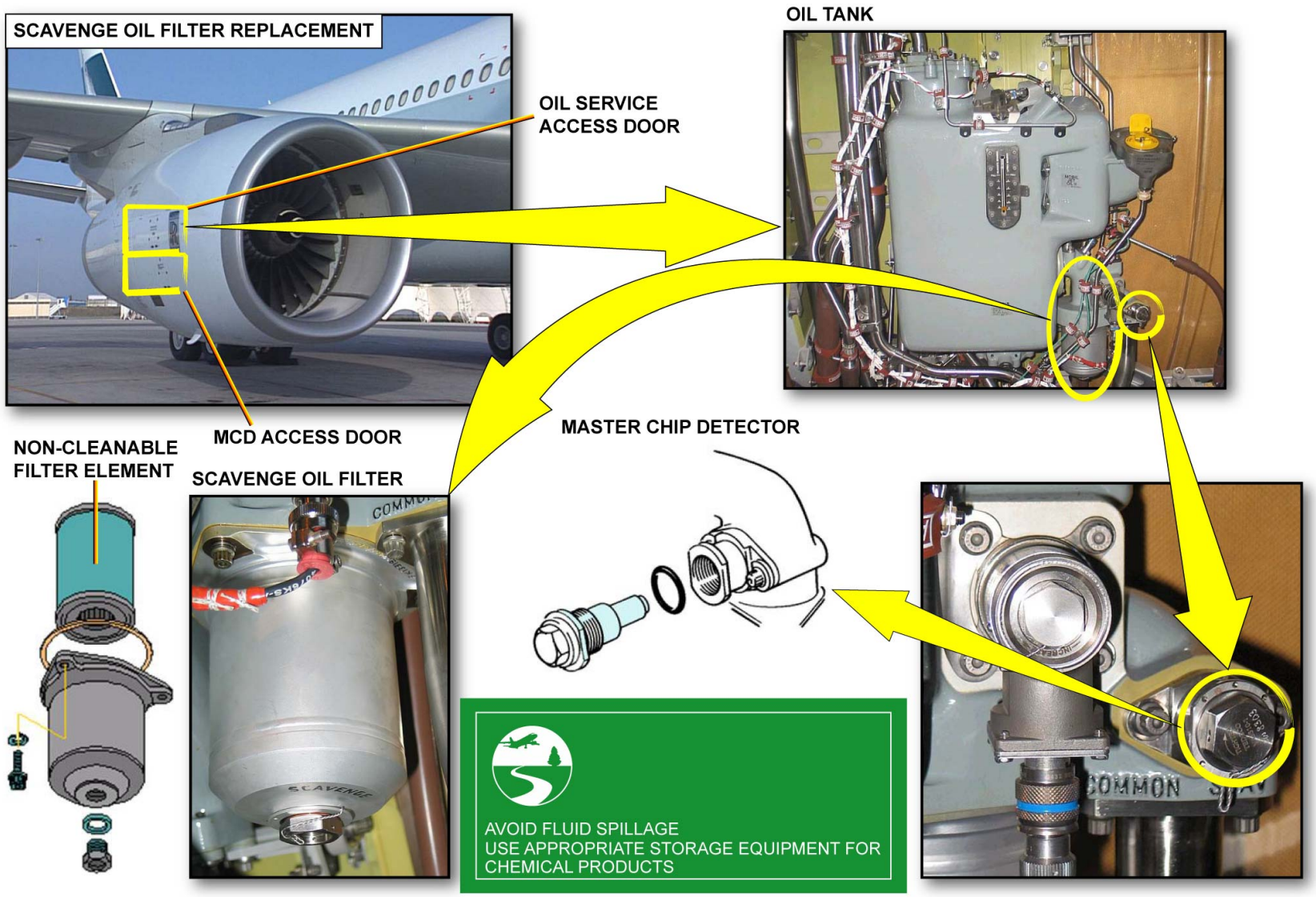
Reference(s)

(o) *Refer to OpsProc 79-09-02D ENG OIL FILTER CLOG Alert*

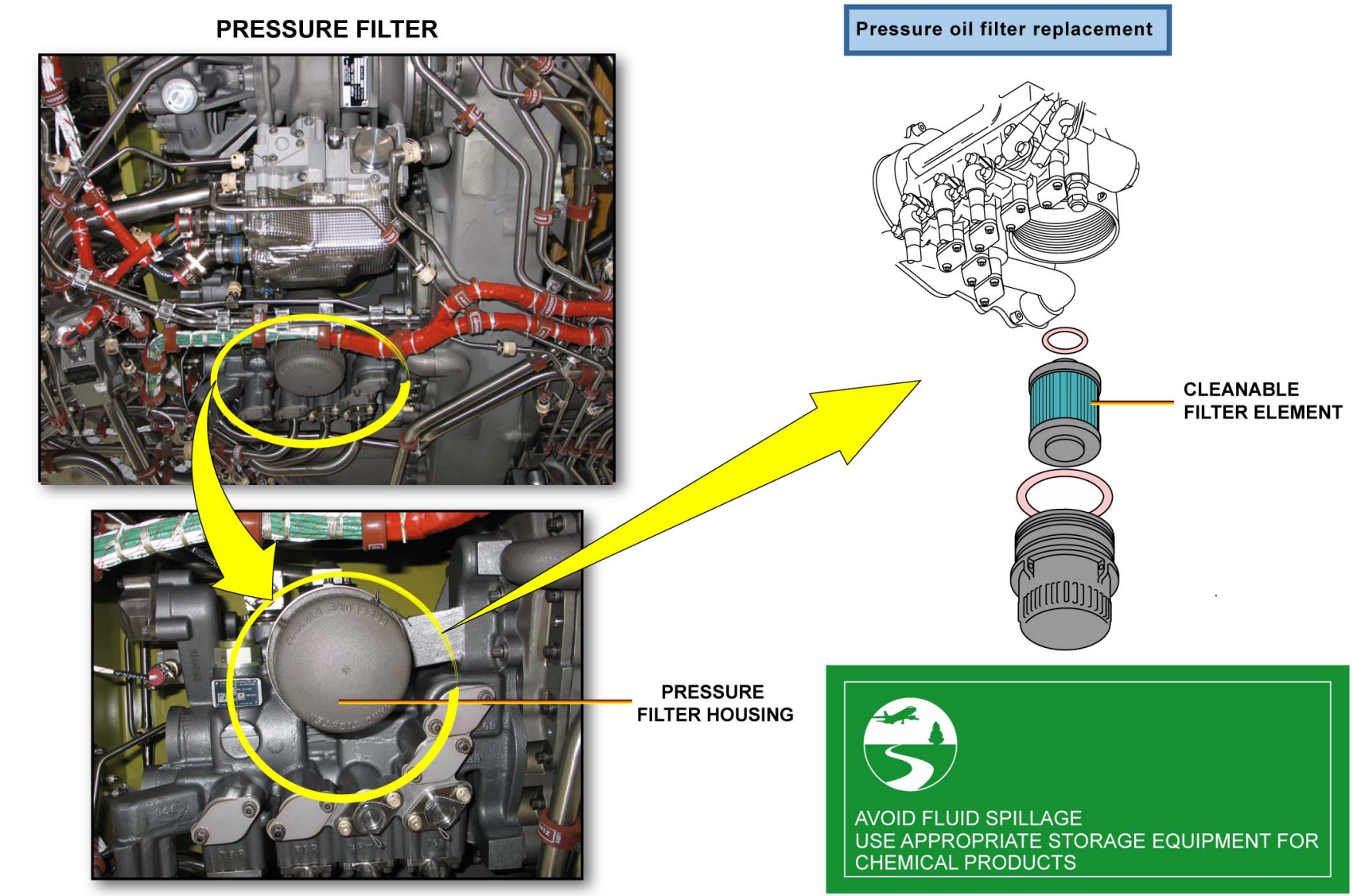
(m) *Refer to AMM 79-35-00-040-809*

Replace oil filter elements

MEL/DEACTIVATION - OIL FILTER CLOG



MEL/DEACTIVATION - OIL FILTER CLOG



MEL/DEACTIVATION - OIL FILTER CLOG

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

START VALVE

In case of a start valve failure, as per the MEL, the aircraft may be dispatched and the engines started by manual operation of the start valve. During this operation, it is important for maintenance personnel to follow the "valve open" and "valve close" commands from the cockpit.

WARNING: During manual start valve operation, respect the inlet and exhaust danger areas. Engine inlet suction is sufficient to pull you into the engine.

The procedure is as follows:

- open the Starter Control Valve and Thrust Reverser Ground Safety Switch access door on the LH fan cowl,
- insert 3/8" square drive in the start control valve manual drive,
- on flight deck command, turn the manual drive counter-clockwise to OPEN the valve,
- on flight deck command, turn the manual drive clockwise to CLOSE the valve,
- after closing the access panel, exit the area using the entry corridor.

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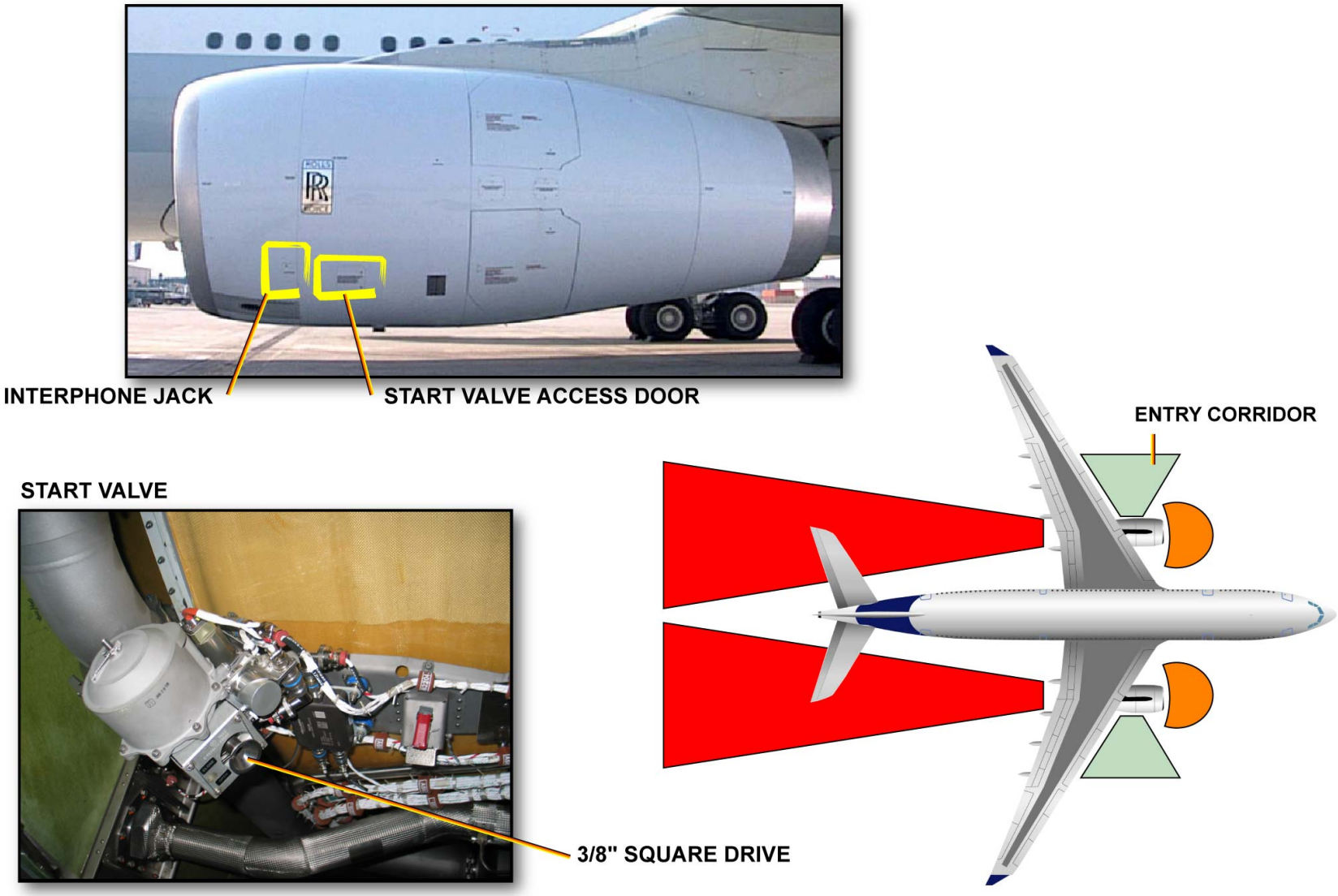

MEL/DEACTIVATION - START VALVE

POWER PLANT SYSTEM LINE MAINTENANCE (2)

ENVIRONMENTAL PRECAUTIONS

Do not discharge products such as oil, fuel, solvent, lubricant either in trash bins, soil or into the water network (drains, gutters, rain water, waste water, etc...).
Sort waste fluids and use specific waste disposal containers.
Each product must be stored in an appropriate and specific cabinet or room such as a fire-resistant and sealed cupboard.

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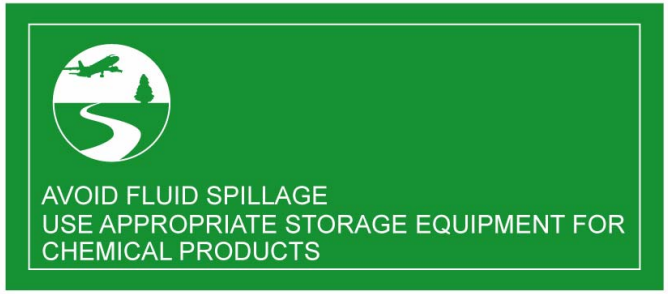
STORE PRODUCTS IN APPROPRIATE CONTAINER/CUPBOARD/ROOM

SORT WASTE FLUIDS IN CONTAINERS



FLUID SPILL CLEANUP KIT

USE SPECIFIC WASTE DISPOSAL CONTAINERS

ENVIRONMENTAL PRECAUTIONS

ENGINE BASE MAINTENANCE (3)

INTRODUCTION

This module will present the maintenance tasks related to the engine storage. These tasks are:
- preservation of the power plant,
- procedure to depreserve the power plant.

CAUTION: you must do all the applicable preservation procedures when you put an engine into storage. If you do not, corrosion and general deterioration of the core engine and the fuel system can occur.

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CAUTION

YOU MUST DO ALL THE APPLICABLE PRESERVATION PROCEDURES WHEN YOU PUT AN ENGINE INTO STORAGE

INTRODUCTION

ENGINE BASE MAINTENANCE (3)

PRESERVATION OF THE POWER PLANT

The preservation procedure protects the Rolls Royce TRENT 700 against corrosion, liquid and debris entering the engine and atmospheric conditions during periods of storage and inactivity.
The time during which the engine will be stored, and the climatic conditions of storage are shown in a chart.
This chart also gives the preservation procedures which must be done in different conditions and for the different storage times. Refer to the Aircraft Maintenance Manual (AMM) for specific storage requests.
To find the applicable preservation procedure you have to:
- find the climatic condition in which the power plant will be stored,
- find the time during which the power plant will be stored,
- compare this data with the chart and make the decision as to which preservation procedures must be done.

To do the preservation of the power plant:
- clean and examine the power plant,
- make sure that the power plant is dry,
- do the applicable preservation procedures,
- attach the applicable covers.

For power plants stored on-wing, desiccant must be used for protection.

NOTE: Note: it is not necessary to put desiccant and Volatile Corrosion Inhibitor (VCI) paper in installed engines, which are put into storage in the desert or in air conditioned hangars. Also, it is not necessary to put an engine into an Moisture Vapor Proof (MVP) bag if it is stored in an air-conditioned hangar.

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Preservation of the power plant

...

Job set-up

...

Find the applicable preservation procedures

Find the climatic condition in which the power plant will be stored.
Find the time during which the power plant will be stored.
Compare data with the chart and choose the adequate procedure to be done.

...

Procedure

...

Do the preservation of the power plant

...

Close-up

...

	CONDITION	STORAGE TIME	PRESERVE THE MAIN LINE BEARINGS	ATTACH THE COVERS AND THE SEALS	USE VPI/CHC PAPER	INHIBIT THE FUEL SYSTEM	INSTALL DESSICANT	INSTALL A REMOVED ENGINE IN A MVP BAG
OUTSIDE	Arid - e.g. desert	Up to 30 days		*		†		
		31 days to 3 months		*		*		
		Over 3 months		*		*		
	Non - arid climate	Up to 30 days		*	*	†	*	
		31 days to 3 months		*	*	*	*	
		Over 3 months	*	*	*	*	*	*
INSIDE	Constant temperature and humidity (air conditioned)	Up to 30 days		*				
		31 days to 3 months		*		*		
		Over 3 months		*		*		
	Non - air conditioned environment	Up to 30 days		*	*		*	
		31 days to 3 months		*	*	*	*	
		Over 3 months	*	*	*	*	*	*

† The engine must be started or the fuel system must be inhibited on the 31st day of storage

If the engine fuel system is not inhibited, the engine must be started every 31 days

PRESERVATION OF THE POWER PLANT

Preservation of the power plant

...
✓ **Job set-up**
...

✓ **Find the applicable preservation procedures**

...
Procedure
...

⇨ **Do the preservation of the power plant**
Clean and examine the power plant.
Make sure that the power plant is dry.
Do the applicable preservation procedures.
For power plants stored on wings, dessicant must be used for protection.
Attach the applicable covers.

...
Close-up
...

PRESERVATION OF THE POWER PLANT

Preservation of the power plant

...

Job set-up

...

Find the applicable preservation procedures

...

Procedure

...

Do the preservation of the power plant

...

Close-up

...

TASK COMPLETED

PRESERVATION OF THE POWER PLANT

ENGINE BASE MAINTENANCE (3)

PROCEDURE TO DEPRESERVE THE POWER PLANT

This procedure gives the details necessary to put the engine back into service after it has been in preservation.
If the engine is in a MVP bag, remove the engine frame from the MVP bag.
To do this, remove the top half of the MVP bag.
Lift the engine until it is cleared of the multi-purpose transportation stand and MVP bag.

WARNING: you must obey the safety instructions when you lift the engine. Death or injury will occur if the engine falls on persons.

Remove the bottom half of the MVP bag.
Install the engine in the multi-purpose transportation stand.
If the power plant is on-wing, get access to the protection covers and caps.
To do this, open the fan cowl doors, deactivate the thrust reverser and open the thrust reverser doors.
Remove the protection covers and caps from the engine, as applicable.
Make sure that all dessicant, protection caps, covers and tape are removed before the engine is put back into service.
Make sure that the work area is clean and clear, close the thrust reverser doors, activate the thrust reverser and close the fan cowl doors.

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Procedure to depreserve the power plant

...
Job set-up
...
Procedure
...

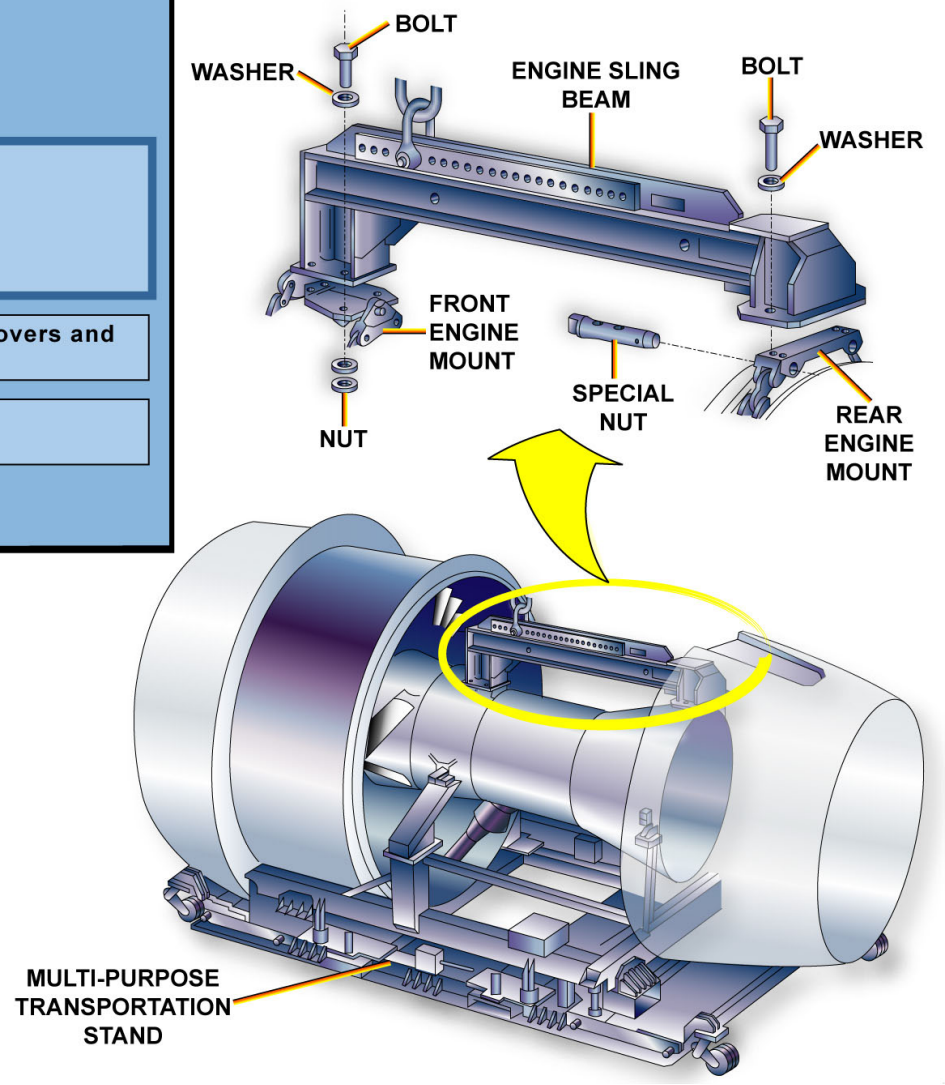
If the engine is in a MVP bag, remove the MVP bag.
Remove the top half of the MVP bag.
Lift the engine.
Remove the bottom half of the MVP bag.
Install the engine in the multi-purpose transportation stand.

If the engine is on-wing, get access to the protection covers and caps

Remove the protection covers and caps

...
Close-up
...

WARNING
OBEY THE SAFETY INSTRUCTIONS WHEN YOU LIFT THE ENGINE



PROCEDURE TO DEPRESERVE THE POWER PLANT

Procedure to depreserve the power plant

...

✓ **Job set-up**

...

Procedure

...

✓ **If the engine is in a MVP bag, remove the MVP bag**

⇨ **If the engine is on-wing, get access to the protection covers and caps**

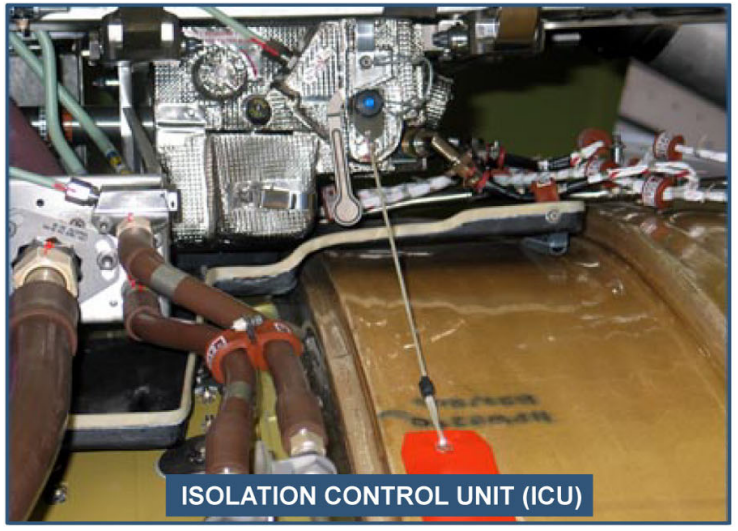
Open the fan cowl doors.
Deactivate the thrust reverser.
Open the thrust reverser cowl doors.

Remove the protection covers and caps

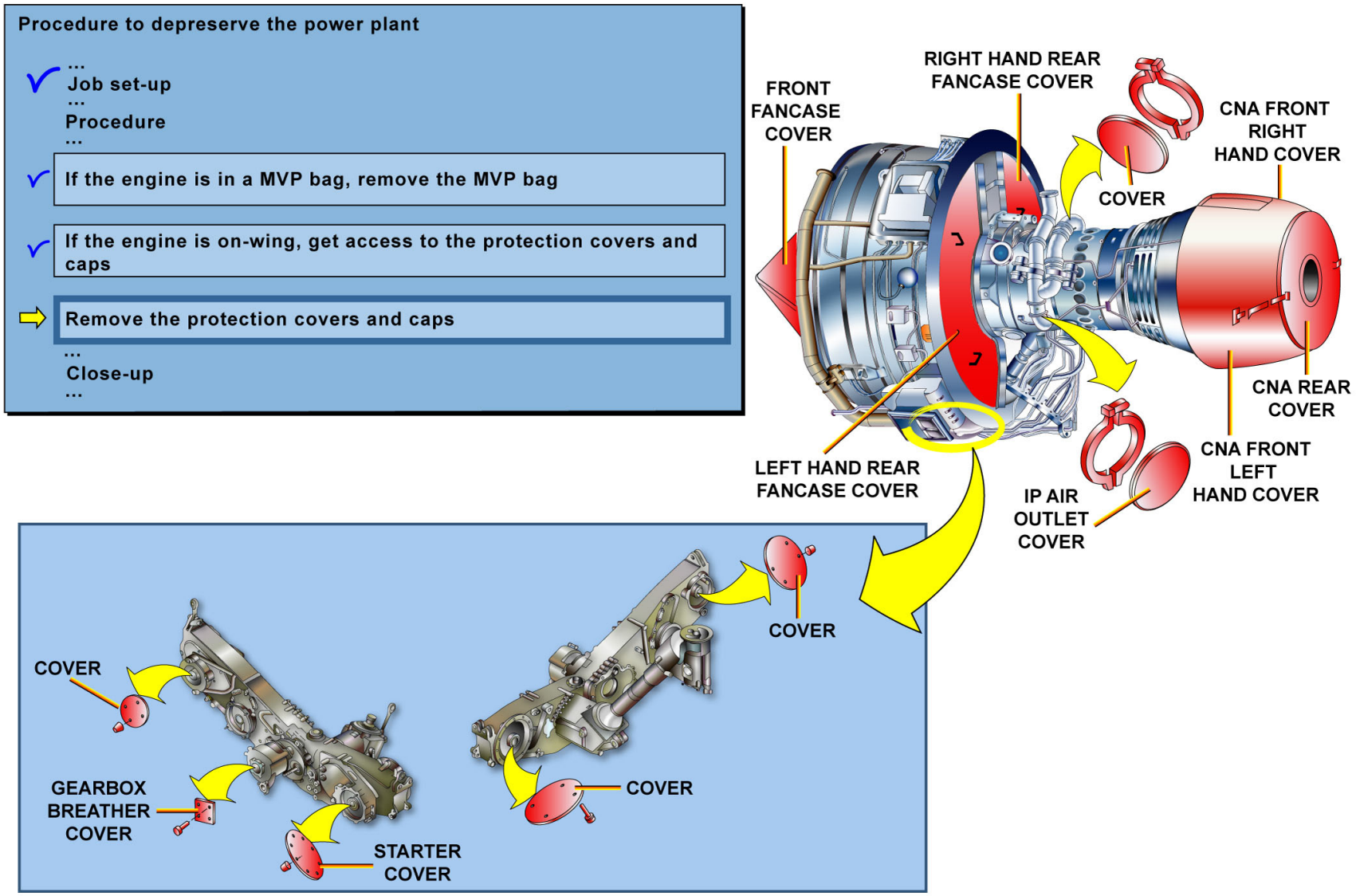
...

Close-up

...



PROCEDURE TO DEPRESERVE THE POWER PLANT



PROCEDURE TO DEPRESERVE THE POWER PLANT

Procedure to depreserve the power plant

...
Job set-up
...
Procedure
...
If the engine is in a MVP bag, remove the MVP bag

If the engine is on-wing, get access to the protection covers and caps

Remove the protection covers and caps
...
Close-up
...

TASK COMPLETED

PROCEDURE TO DEPRESERVE THE POWER PLANT

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31707 BLAGNAC cedex, FRANCE
STM
REFERENCE GCL13151
APRIL 2013
PRINTED IN FRANCE
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